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Long-Term Effects of Land Application of Domestic Wastewater: Camarillo, California Irrigation Site

Robert S. Kerr Environmental Research Lab.
Ada, OK

Prepared for

Ralph Stone and Co, Inc.
Los Angeles, CA

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Camarillo, California Irrigation Site

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This report presents the results of an assessment of the long-term impacts on crops, soils, and groundwater resulting from irrigation with secondary-treated municipal effluent. The concentrations of pathogens, nutrients, heavy metals and salts in soils, groundwater, and crops irrigated with secondary-treated wastewater were compared to the concentrations in soils, groundwater, and crops irrigated with conventional water supplies. Test and control sites at Camarillo, California were selected as case studies for comparisons. Both sites produced row crops for human consumption and were irrigated primarily by the furrow method. The test site had been irrigated with effluent for over ten years. The control site had never received wastewater but had been irrigated for at least ten years with conventional water. Lysimeters were placed at various depths in the soil of the test and control sites to test for the constituents in the leachate. Sampling wells were drilled at the test site to determine the upper groundwater quality affected by the leachate.

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Camarillo, California, Irrigation Site

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FOREWORD

The Environmental Protection Agency was established to coordinate the administration of major Federal programs designed to protect the quality of our environment.

An important part of the agency's effort involves the search for information about environmental problems, management techniques, and new technologies through which optimum use of the nation's land and water resources can be assured and the threat pollution poses to the welfare of the American people can be minimized.

EPA's Office of Research and Development conducts this search through a nationwide network of research facilities. As one of these facilities, the Robert S. Kerr Environmental Research Laboratory is responsible for the management of programs including the development and demonstration of soil and other natural systems for the treatment and management of municipal wastewaters.

Although land application of municipal wastewaters has been practiced for years, there has been a growing and widespread interest in this practice in recent years. The use of land application received major impetus with the passage of the 1972 amendments to the Federal Water Pollution Control Act. The 1977 amendments to the Act gave further encouragement to the use of land application and provided certain incentives for the funding of these systems through the construction grants program. With the widespread implementation of land application systems, there is an urgent need for answers to several major questions. One of these questions regards the long-term effects of land application on the soil, crops, groundwater, and other environmental components. This report is one in a series of ten which documents the effects of long-term wastewater application at selected irrigation and rapid infiltration study sites. These case studies should provide new insight into the long-term effects of land application of municipal wastewaters.

This report contributes to the knowledge which is essential for the EPA to meet the requirements of environmental laws and enforce pollution control standards which are reasonable, cost effective, and provide adequate protection for the American public.

William C. Galegar
Director
Robert S. Kerr Environmental Research Laboratory

ABSTRACT

This report presents the results of an assessment of the long-term impacts on crops, soils, and groundwater resulting from irrigation with secondary-treated municipal effluent. The concentrations of pathogens, nutrients, heavy metals and salts in soils, groundwater, and crops irrigated with secondary-treated wastewater were compared to the concentrations in soils, groundwater, and crops irrigated with conventional water supplies. Test and control sites at Camarillo, California were selected as case studies for comparisons. Both sites produced row crops for human consumption and were irrigated primarily by the furrow method. The test site had been irrigated with effluent for over ten years. The control site had never received wastewater but had been irrigated for at least ten years with conventional water. Lysimeters were placed at various depths in the soil of the test and control sites to test for the constituents in the leachate. Sampling wells were drilled at the test site to determine the upper groundwater quality affected by the leachate.

This report was submitted in fulfillment of Contract No. 68-03-2362 by Ralph Stone and Company, Inc., under the sponsorship of the United States Environmental Protection Agency. This report covers the period from January 2, 1976 to February 28, 1978, and work was completed as of May 3, 1978.

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LIST OF SPECIAL ABBREVIATIONS[a]

ABBREVIATIONS

AE -- acid extractible
C -- composited sample (i.e., the sample was composited with another sample)
CEC -- cation exchange capacity
EX -- exchangeable
Fa -- fall
FC -- fecal coliform
NA -- not available
NES -- not enough sample
Org -- organic
Sp -- spring
Su -- summer
T -- total digestible
TC -- total coliform
TDS -- total dissolved solids
TOC -- total organic carbon
W -- winter
WE -- water extractible

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[a] Conventional biological and chemical symbols and abbreviations are not included in the above listing.

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SECTION 1

INTRODUCTION

The widespread application of treated wastewater for irrigation is limited primarily by certain economic, technical and public health uncertainties about the impacts of such use. In addition to costs, there is concern that the quality of our foodstuffs, land resources, and groundwater resources may be partially impaired due to residual contaminants present in the treated effluent. For instance, high total salt concentration (salinity) of irrigation water can greatly reduce the total crop yield. Concentrated dissolved solids can severely deter plant growth. The salt content of the soil moisture strongly affects the osmotic relationships within plants since high salinity interferes with the plant's ability to take up water. Furthermore, saline irrigation water may create an unfavorable nutrient balance in the soil. Undesirable concentrations of toxic heavy metals, or salts in treated effluent may originate from the discharge of noxious chemicals by manufacturing plants, commercial or even domestic sources having, for example, photographic dark rooms or zeolite water softeners.

Salinity may also adversely affect the structure of the soil by changing the chemical and physical properties of clays and other minerals. For instance, when calcium is the predominant cation, the soil usually has a granular structure which is easily worked and readily permeable. As the calcium is replaced by sodium, however, the clay becomes dispersed and the soil becomes less workable and more impermeable.

Trace heavy metals and other toxic constituents in the irrigation water may be dangerous for two reasons. Many trace metals are phytotoxic. Aluminum, boron, copper, manganese, selenium, and silver are some of the more notable examples. Phytotoxins may kill a plant outright, but more often they inhibit and weaken its growth, reduce yield, or produce a food product of inferior quality. Another potential problem lies in biomagnification - the tendency for many plants to absorb and concentrate some toxic substances. This tendency is pronounced in the case of the absorption of mercury by aquatic algae and fish in the food chain, but similar problems may occur in terrestrial plants, albeit to a lesser extent. Some of the toxic substances which are subject to biomagnification are cadmium, molybdenum, selenium, and fluoride. In food crops, this could present a hazard to human health. The significance of long-term application of heavy metals to agricultural soils, from wastewater irrigation will depend on whether these metals are ultimately absorbed by plants, or if they assume inert chemical forms in the soil that cannot be absorbed by plants, or are leached into the groundwater.

Pathogens can also be a problem when irrigating with sewage effluent. This is of particular concern when the crop is to be consumed raw by humans. Pathogenic protozoa, bacteria, viruses, and other organisms can enter plant tissues in a variety of ways and may even be found in the edible portion of the plant. One solution to this problem is to irrigate only grasses or pasture land with reclaimed water; however, there is still concern about possible bacterial or other infection of grazing livestock. Some pathogens present in raw sewage may also represent a hazard to the plants . Certain fungi,bacteria, protozoa, and nematodes can attack vegetation,damaging the growing plants,and severely affecting the yield.

Dissolved salts, heavy metals, and pathogens also pose a potential danger to the usable groundwater supplies. Usually, the nature of the soil is such that insoluble solids, some ions, heavy metals, and pathogens are effectively removed by adsorption, precipitation, or exchange within the first few feet of fine-grained soil. However, a bypass of raw sewage, such as through an uncapped well or bedrock fissure directly into potable groundwater aquifers, may cause an epidemic or other contaminative outbreak. Nevertheless, land disposal in general, has been found to be a superior biological filter, greatly reducing health hazards and other adverse environmental impacts when contrasted with water disposal.

Before irrigation with sewage effluent can be significantly expanded, a detailed assessment of its long-term effects is required. The purpose of this study was to evaluate the long-term environmental and cost impacts resulting from irrigating farm land with secondary treated municipal effluent. The major areas of concern were: impacts of the wastewater on groundwater, soils and crop quality; changes in the crop yield and uptake of minerals; costs of crop production using wastewater; and the environmental health hazards. Specifically, the objectives were to:

- Sample soils (at the begining and the end of the monitoring program), harvested crops, and water (irrigation water, leachate, and upper groundwater).
- Contrast the effluent-treated test site biological (including pathogens), physical and chemical characteristics of the soils, crops, irrigation water, percolating water and groundwater with similar data obtained at the control site.
- Contrast the agricultural costs and crop yields.
- Evaluate other environmental and health effects.

The first step in implementing the study was to select a separate effluent irrigation site and a paired normal irrigation site. This was done by reviewing a computerized list of existing effluent irrigation sites supplied by the U. S. Environmental Protection Agency, as well as by reviewing current literature. A group of 30 candidate sites in California were selected for intensive technical evaluation based on the preselection criteria. Of these, five locations were chosen for visitation and final review. Camarillo, California, classified as having a semi-arid climate, was ultimately selected for the assessment of the long-term environmental impact of irrigating with sewage effluent. Separate test and control sites were obtained.

Site specific but uniform monitoring programs for both the test and control sites at Camarillo were developed. Soil samples, collected at several depths at the beginning and at the end of the monitoring program, were examined for biological organisms and physical properties, and analyzed for chemical constituents (including nutrients, heavy metals, and salts).

The tissues of harvested crops were tested for pathogens and chemical constituents. Chemical and biological analyses were made twice each month on the irrigation waters (treated effluent from the test site and municipal water supply from the control site), percolating water, and upper groundwater. The data collection, laboratory analyses, and office studies were conducted over a 24-month period, including 18 months of field sampling from August,1976 to January,1978.

SECTION 2

CONCLUSIONS

The long-term effects from crop irrigation of municipal secondary treated wastewater were evaluated by comparing a test site irrigated for over 10 years with secondary treated effluent, with a similar control site irrigated with normal potable water. General conclusions on land disposal by crop irrigation include those related to overall site and effluent impacts and requirements.

Due to a combination of variable crop irrigation schedules and the total irrigation volume being less than the effluent volume, facilities for effluent storage and bypass into a stream bed were needed at Camarillo. Where sufficient cropland is available to utilize all of the effluent from a wastewater plant for crop irrigation, storage facilities would still be needed due to the variable crop irrigation schedules.

Irrigation water was applied by furrow irrigation at the test and control sites when the crops had grown above ground. Avoidance of spray irrigation reduced the potential public exposure to the wind-blown effluent. No flies or sewage odors were detected on the effluent irrigated test site. After over 18 years of continuous land disposal of effluent at Camarillo, no adverse health effects were reported on farm workers, consumers, or wastewater treatment plant personnel. Available information on the incidence of illness of farm and treatment plant workers indicated no difference from other local farm or industrial workers. A well oxidized, clear, odor-free disinfected effluent is desirable to avoid potential dangers and nuisances that may be associated with effluent land disposal.

Farmers and their advisors were neither knowledgeable about, nor saw great benefits in using reclaimed wastewater effluent for crop irrigation. Education and information programs for farmers on the availability and cost benefits of using effluent for crop irrigation would enable farmers to more realistically assess effluent irrigation for their crops.

Although use of treated wastewater for land irrigation requires a separate set of water pumping and distribution lines, the irrigation costs were lower when compared with conventional water supplies because of the lower cost of effluent.

The areas of concern in using treated effluent for irrigation water included: hazards to farm workers' health, contamination of the soils, crops, or the groundwater underlying the effluent irrigated site, changes in the crop yield, uptake of minerals and nutrients, costs, and nuisances. Specific conclusions relating to these areas of concern are presented below:

BIOLOGICAL AND CHEMICAL ANALYSIS OF WATER AND SOILS

1. The major significant difference between the test site effluent and the control site irrigation water was the total dissolved solids which was 36 percent higher in the test site effluent. In particular, sodium and chlorides (by 140 and 270 percent) contributed most of the higher dissolved solids. The test site effluent also provided considerably greater nutrient value: total nitrogen by 330 percent, phosphates by 2,260 percent, and potassium by 810 percent. The heavy metals, in general, did not differ significantly between the test and control sites' irrigation waters. The minerals boron and fluorides (by 270 and 160 percent) were significantly greater in the test site effluent. The total and fecal coliform averaged about 57,000 MPN/100 and 220 MPN/100 ml, respectively, in the test site effluent as compared to 2 MPN/100 ml for both in the control site irrigation water. The statistical evaluations showed that the differences were probably insignificant due to a large standard deviation in the test site data. The difference is, however, meaningful in that essentially no (< 2 MPN/100 ml) coliform were detected in the control site irrigation water.

2. The leachate, at the 50-and 100-cm depths, from the test site generally did not differ significantly from the control site leachate. In fact, the following constituents, which were significantly different in the irrigation water, did not differ significantly between the test and control site leachate samples: total dissolved solids (at the 50 cm depth), fluorides, total nitrogen, total organic carbon, phosphates, sodium, and copper. Only potassium and sulfates were significantly different at both depths. The total dissolved solids, calcium and zinc, at the 100-cm depth were lower by 23, 62, and 58 percent, respectively, in the test site leachates, while boron was significantly higher, by 57 percent. Chlorides, fluorides, molybdenum, and lead showed probable significant differenees at the 90 to 95 percent level.

3. Some leachate constituents increased in concentration with depth. For both the test and control sites, the total dissolved solids increased from below,1,000 mg/l in both irrigation waters to over 1,900 mg/l at the 100-cm subsurface depth. Similarly, nitrates,(by about 600 percent), total nitrogen (by about 100 percent), and sodium (by about 25 percent) also experienced significant increases in concentration with depth for both sites. The indication is that these constituents were readily leached from the soil. Effluent land application proved an effective method of attenuating total organic carbon and phosphates as shown by the decrease in concentration with depth for these latter constituents at the test site. Total and fecal coliform were effectively attenuated at both the test and control sites.

4. The samples from the on-site lateral and downstream well at the test site showed that some total dissolved solids(including chlorides, magnesium and sodium

as primary constituents) leached through to the upper layer of the groundwater. Total nitrogen, and nitrates likewise, were greater in the groundwater test samples downstream from the test site, indicating that nitrogen passed through the soil. The other nutrients, potassium and phosphates, were either utilized by the crops or retained in the soil. In fact, potassium was found to be present at lower levels downstream from the test site. Boron, fluoride, and total organic carbon, which were significantly greater in the test effluent, were at lower levels in the groundwater. Heavy metals, and total and fecal coliform, did not differ significantly in the on site, lateral and downstream groundwater samples.

5. The chemical characteristics of the test and control site soils differed for both the initial samples and final samples taken about one year later. Some soil constituents that changed during the one-year period between samplings included the cation exchange capacity which increased from 12.2 to 24.0 at the control site, and from 14.3 to 29.0 at the test site. These increases were supported by significant increases in exchangeable calcium (26 percent) and exchangeable magnesium (69 percent) in the control site soil, and an increase of exchangeable magnesium in the test site soils. Thus, the increases in cation exchange capacity in soils at both sites indicated that lime had been added. A substantial quantity of lead pollution was found in the control site soil, which was attributed to the close proximity of the control site to a heavily travelled interstate highway. The control site soil contained nearly 1,400 percent more total and acid extracted lead at the 1-to 10-cm subsurface soil depths than the test site. The difference in lead content was not observed below the 10-cm depth.

6. The biological populations of protozoa, nematodes, and total and fecal coliform, were similar for both the test and control sites in the initial and final soil samples. In all cases the biological populations decreased with depth. No statistically significant differences were identified between the test and control site soil biological populations. The biological population was reduced to non-detectable or near non-detectable levels after percolation into soils below 100-cm depths.

TEST SITE GROUNDWATER QUALITY COMPARISON

The analytical results of the test sites' groundwater samples for the study period were compared with the U.S. Environmental Protection Agency 1975 interim primary drinking water regulations and the water quality criteria for municipal water supplies, with the results found as follows:

1. Water quality criteria for potable and other uses was not exceeded in the groundwater samples at any time in any of the three wells (on-site, lateral, downstream) for fecal coliform, barium, copper, nickel, zinc, arsenic, and selenium.

2. Water quality criteria for total dissolved solids, sulfate, and nitrate were exceeded in all three wells about 100 percent of the time.

3. The criteria were exceeded at various times in all three wells for cadmium (average 62 percent), chromium (average 44 percent), and lead (average 79 percent). Other less toxic constituents also exceeded the criteria in all three wells by varying percentages.

4. There were not significant differences in the upper groundwater sample constituents in the on-site, lateral or downstream test site monitoring wells.

CROP TISSUE ANALYSES

1. Spinach leaves at the control site were found to exceed the expected levels for the following elements: calcium (4,950 versus 100 to 2,000 mg/kg, magnesium (7,080 versus 500 to 1,200 mg/kg), and copper (22 versus 1 to 20 mg/kg).

2. Broccoli at the test site exceeded the expected range for the following elements: phosphorus (6,037 and 11,712 versus 300 to 1,000 mg/kg), calcium (2,025 and 7,725 versus 100 to 1,500 mg/kg), potassium (10,000 and 13,737 versus 1,000 to 3,000 mg/kg), and magnesium (2,821 and 4,600 versus 500 to 1,500 mg/kg).

SOIL NUTRIENTS

1. The nutrients in the soil samples at the test site increased, on an average annual basis, by the following amounts: nitrogen (27 kg/ha/yr), phosphorous (331 kg/ha/yr), and potassium (29 kg/ha/yr). The increase was attributed to the nutrients added in the effluent being greater than the leaching and crop uptake of nutrients. All of the potassium taken up by crops at the test site was provided by the effluent.

2. On the control site, nitrogen (57 kg/ha/yr) and potassium (42 kg/ha/yr) were depleted, and phosphorus increased (72 kg/ha/yr).

3. The total nutrients provided by the wastewater in kg per hectare per year were: nitrogen - 391; potassium - 312; and phosphorus - 156.

CROP YIELDS

1. The crop yield on the test site averaged 12 percent greater for tomatoes, and 4 percent greater for broccoli than on the control site over a 13-year period.

2. The physical appearance of crops grown with effluent was similar to crops grown with potable water.

CROP ECONOMIC ANALYSIS

1. The net profit per hectare on identical crops grown on the test site exceeded the profits for the control site by an average of $278 for tomatoes and $188 for broccoli.

The higher test site profits resulted from the lower cost for the effluent compared to the cost of purchasing potable water and fertilizer.

SECTION 3

RECOMMENDATIONS

1) Special studies on viruses present in effluent applied to and present in edible crops should be conducted. The studies would provide a meaningful data comparison for existing effluent and conventional water irrigation crop sites. Analyses should be conducted for selected viruses such as polio and influenza in the treated wastewater, soils, crops, leachate and groundwater.

2) Toxic elements found in the wastewater may enter crops. Standard bio-assay tests are recommended to assess the toxicity of the effluent, crops, soils, leachates, and groundwater at land disposal sites. Bio-assay methods should include bacterial tests, fish exposure, or other techniques. Biochemical oxygen demand or bacterial respiration tests should also be used as an indicator.

3) Plant and animal disease studies are desirable to assess the potential effects of effluent. The work should include field and controlled laboratory scale tests to define quantitative effluent parameters.

4) Epidemiological studies should be conducted on the health of the populations surrounding the effluent irrigation sites.

5) Public agency personnel, farmers, farm workers, and farm advisors associated with reclamation and conventional water supply sites should be surveyed for attitudes toward the effectiveness of wastewater land disposal irrigation.

6) Industrial wastewater pretreatment programs on plant effluent quality and land disposal should be investigated.

7) A demonstration and an educational program should be developed to acquaint farmers with the availability, usefulness and cost-effectiveness of effluent for crop irrigation.

8) Vertical type studies of the quality and marketability of effluent-irrigated crops starting with the farmers, processors and distributors to the consumers should be performed.

9) Pilot tests and field demonstrations to optimize crop yields and define realistic effluent irrigation rates should be conducted.

10) The nutritional value of food or other crops grown with wastewater irrigation should be compared to food or other crops grown with conventional water.

11) Studies to assess the future viability of the land disposal alternative in areas where communities are rapidly growing should be performed. The survey should assess the availability of existing farm land for effluent irrigation, and the encroachment of various types of development on existing effluent irrigation programs.

SECTION 4

SITE SELECTION

PRELIMINARY SCREENING

The search for an appropriate test site began with a list provided by the United States Environmental Protection Agency indicating wastewater treatment plants in California, Nevada, and Arizona which employed effluents for irrigation. This was supplemented by additional information obtained during a literature survey. From over 100 candidate sites, thirty California sites were chosen for closer study. These community sites are shown on Figure 1. The sites were then evaluated by the criteria shown in Table 1.

Based on these criteria, five sites were selected for final screening; they are also shown on Figure 1. Telephone calls and confirmatory letters were sent to the concerned authorities at the five selected sites to explain the project and to request their cooperation for field visits.

FINAL SELECTION

The five California sites were visited and inspected during the second week of February 1976. On-site inspections related to soils, crops, treatment works, effluent storage facilities, irrigation procedures, staffing, anticipated future land use, potential control site locations,etc. The advantages and disadvantages of each are summarized in Table 2. From this information, two California sites were ultimately selected as being potentially the best in fulfilling the general criteria. They were visited once again during February,1976; this time in the company of Dr. William Duffer, Project Officer. The review visits developed further information supplementing that previously gathered.

In April,1976, the Project Officer approved the Camarillo test site. A detailed description of the project site is included as Appendix A, "Site Description." A map showing the Camarillo area is shown on Figure 2.

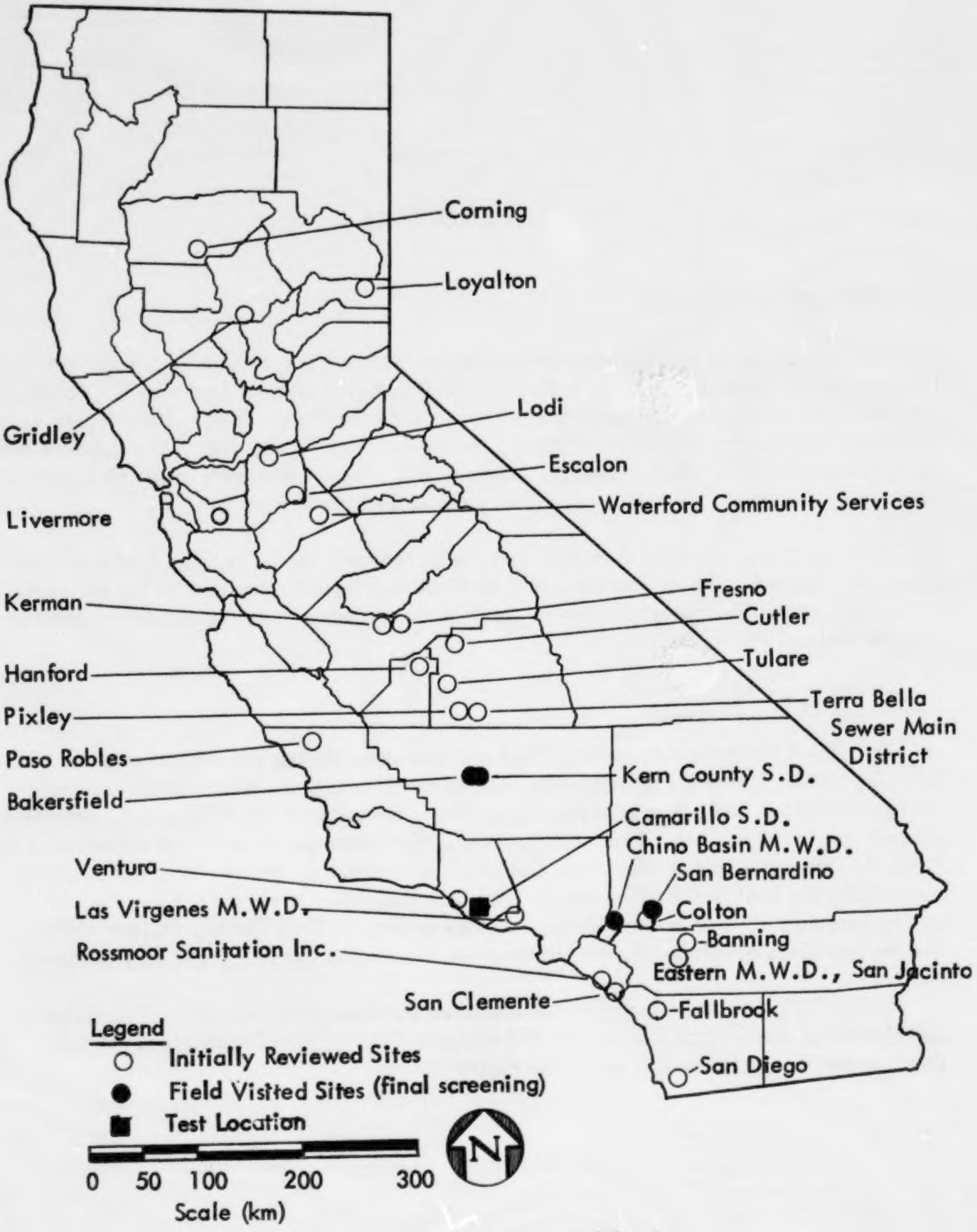

Corning
Loyalton
Lodi
Gridley
Escalon
Waterford Community Services
Livermore
Fresno
Kerman
Cutler
Tulare
Hanford
Terra Bella
Pixley
Sewer Main District
Paso Robles
Kern County S.D.
Bakersfield
Camarillo S.D.
Chino Basin M.W.D.
San Bernardino
Ventura
Colton
Las Virgenes M.W.D.
Banning
Rossmoor Sanitation Inc.
Eastern M.W.D., San Jacinto
San Clemente
Fallbrook
San Diego
Legend
○ Initially Reviewed Sites
● Field Visited Sites (final screening)
■ Test Location
0
50
100
200
300
Scale (km)
N

Figure 1. Site locations: California.

TABLE 1. SITE SELECTION CRITERIA

Parameter	Criteria
Provision for secondary treated effluent	--
Continuous irrigation with effluent	≥ 10 years
Average daily effluent flow	≥ 365 kiloliters
Average annual effluent application	1.83 meters
Availability of records on local groundwater quality	--
Future continued use of the site for irrigation	--
Availability of the test site of a comparable control area unaffected by the effluent irrigation operation and receiving normal irrigation water	within 1.6 km
Cooperation of local authorities and farmers	--
A variety of major crops grown on effluent-irrigated land	--
Proximity of land receiving the effluent to the treatment plant	--
Sites located in arid and semi-arid regions	--

TABLE 2. SUMMARY OF FINAL SITE SELECTION CRITERIA DATA ON FIVE CALIFORNIA SITES

Site	Effluent Type	Irrigation Period (years)	Irrigated Area (hectares)	Advantages	Disadvantages
Confidential	Primary treated	40	890.7	Variety of crops available for study. No discharge of effluents into surface waters. Wells available for sampling groundwater.	Upstream control site not available due to residential development. Full cooperation of tenant farmer is doubtful. Very little monitoring data is available on effluent. No available historic soil and vegetation data. Natural irrigation water is mixed with effluent irrigation. Primary treated effluent used for irrigation. Three-hour one way driving time from Los Angeles Company office. No monitoring wells other than groundwater supply wells.
Kern County Sanitation District	Primary and some secondary treated	30	445.3	No discharge of effluent into surface waters. Wells available for sampling groundwater.	Upstream control site not available due to residential development. Full cooperation of tenant farmers is doubtful. Limited monitoring data available on effluent operations Primary/secondary effluent mixture is used. Three-hour one way drive to Los Angeles Company office. No monitoring wells other than groundwater supply wells.

(Continued)

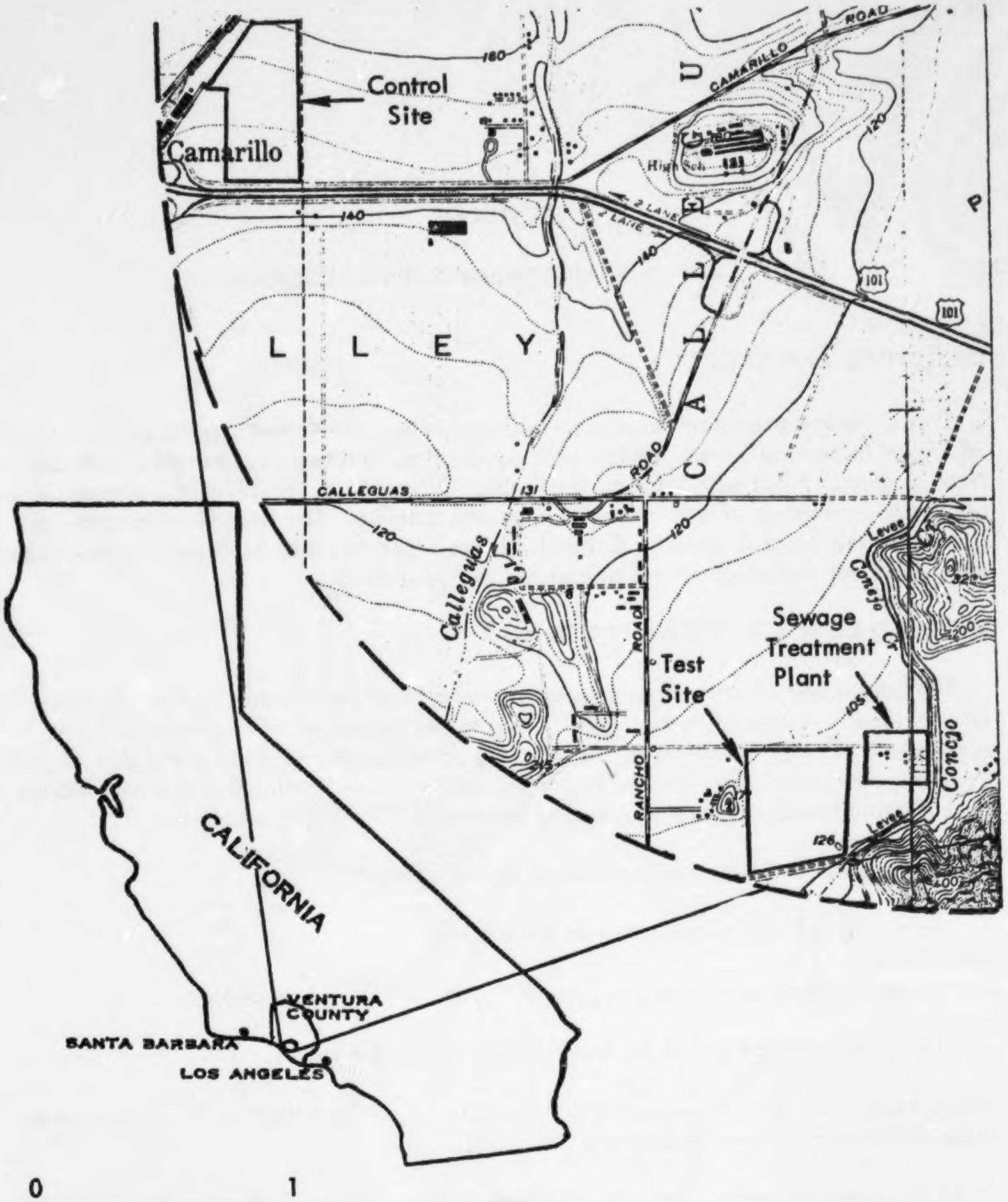
TABLE 2. (continued)

Site	Effluent Type	Irrigation Period (years)	Irrigated Area (hectares)	Advantages	Disadvantages
Chino Basin Municipal Water District	Tertiary treatment since 1973. Secondary treated effluent used prior to 1973.	52	Golf course uses 492 million liters/yr. Remainder is discharged into Santa Ana River.	Excellent data on monitoring program since 1973. Wells are available for sampling groundwater. Our company designed the facility and thus has knowledge of operation.	No similar golf course control site available within 1.6 km. Limited historic data available on soil and groundwater. No monitoring wells exist other than groundwater wells.
Confidential	Tertiary treated	6	Golf course and freeway landscaping, and treatment plant grounds are irrigated.	Excellent data on effluent monitoring program. Control golf course irrigated with normal water supply is available upstream. Tenants will cooperate. Soil analyses data for past 5 years available from tenant. Drinking water well on both sites for sampling groundwater.	Control golf course uses herbicide, fungicide, and sewage sludge soil conditioner which created different conditions between the test and control sites. No historic data are available on groundwater. Quantity of effluent used for golf course irrigation is not known. Majority of effluent is discharged into a river.
Camarillo Sanitation District	Secondary and tertiary (partial) treated	10	182.2	A variety of row crops (vegetables) are grown on effluent-irrigated land. Excellent historic data on effluent. Full cooperation from tenant farmer is anticipated. Similar	No other monitoring wells besides groundwater wells. No historic data on groundwater or soil. Conventional irrigation water may be mixed with effluent irrigation water during peak summer irrigation.

(continued)

TABLE 2. (continued)

Site	Effluent Type	Irrigation Period (years)	Irrigated Area (hectares)	Advantages	Disadvantages
Camarillo Sanitation District (continued)				farm and crops nearby for control site. Groundwater wells can be used for sampling. Full cooperation from sanitation district is assured. One-hour one way drive from Los Angeles office.	


Control Site
Camarillo
CAMARILLO ROAD
High Sch.
2 LANE
101
V A L L E Y
CALLEGUAS
ROAD
Calleguas
Conejo
Levee
Sewage Treatment Plant
Test Site
RANCHO ROAD
180
140
120
131
126
105
322
200
CALIFORNIA
VENTURA COUNTY
SANTA BARBARA
LOS ANGELES
0
1
Scale in km
N

Source: 1.

Figure 2. Study area – test and control farm sites.

SECTION 5

SAMPLING AND MONITORING PROGRAM

OBJECTIVES AND SCOPE

Following the site selection process outlined in Section 4, the general objectives described in Section 1 were implemented by developing a tentative sampling and analytical program. After submission to the Project Officer in June, 1976, the program was revised in September 1976 to render it more site specific. The final field sampling and laboratory test program used for Camarillo is presented in Table 3. Sampling procedures and analytical methods used are referenced in Appendix B.

TEST AND CONTROL SITE MONITORING

The comparison of critical parameters between an effluent-irrigated test site and a conventionally-irrigated control site is basic to the assessment of long-term effluent application effects. Monitoring and sampling activities on test and control sites at each location were identical and closely coordinated by timing to minimize external factors. Coordination of monitoring and sampling involved the following practices:

- Using uniform field sampling methods and equipment.
- Sampling test and control sites on the same day.
- Using identical sample storage, handling,and analytical procedures.
- Using the same personnel for sampling/analysis at both sites.

Where individual farm procedures or factors differed between the test and control sites, these differences were evaluated and described.

Descriptive information was obtained from each site for the following:

- Historical farming practices.
- Fertilizer and pesticide application rates.
- Irrigation water source, quality, quantity, and frequency.

TABLE 3. TEST AND CONTROL SITES - REVISED SAMPLING AND ANALYSIS PROGRAM (September 1976)

Sample Type	Location	Sampling Frequency	Number of Samples	Constituents for Analysis	Number of Analyses per Site Test	Control	Total
Soil	2 samples per site. Depths of 0-2, 2-4, 9-11, 29-31, 95-105 (10 sub-samples composited per sample), 195-205, and 295-305 cm.	1	14	Moisture and organic content, hydraulic conductivity, particle density, bulk density, particle size distribution. Soil pH (7)	98	98	196
Soil	2 samples per site. Depths of 0-2, 2-4, 9-11, 29-31, 95-105 (10 sub-samples composted per sample), 195-205 and 295-305 cm.	2 1st mo. and after 1 crop is harvested	28	CEC, extractable Soluble Salts (Ca, Mg, K, Na), P (as PO_4), N (as NO_3 and KjN), B, Cl, F, Cu, Ag, Hg, Pb, Cr, Cd, As, Ba, Mn, Mo, organic P, extractable P, Se, Zn; exchangeable cations (Ca, Mg, Na, K); extractable metals (Mg, As, Cu, Ag, Hg, Pb, Cr, Cd, Mn, Ni, Se, Zn); PCB, total and fecal coliform, protozoa, and nematodes (46)	1,288	1,288	2,576
				Total soils	1,386	1,386	2,772
Irrigation water	Treatment plant or main irrigation pipeline	2 x/month 13 months	26	TDS, coliform, fecal and total (3)	78	78	156

(continued)

TABLE 3 (continued)

Sample Type	Location	Sampling Frequency	Number of Samples	Constituents for Analysis	Number of Analyses per Site Test	 Control	 Total
Irrigation water (Cont.)		Monthly composites of 2x/month samples, 13 times	13	P(as PO_4), NO_3, Ca, K, Pb, Na, Mg, Cl, F, Cr, Cd, Cu, B, As, Ba, Mo, Se, Zn, total N, TOC, TVOC, PCB, SO_4, Ni (24)	312	312	624
Groundwater	3 wells per site, each at 2 depths within the groundwater aquifer	2x/month at 2 depths within each well, 32 times	192	TDS, coliform, total and fecal (3)	576	576	1,152
		Monthly composites of 2x/month samples, 16 times	96	P(as PO_4), NO_3, Ca, K, Pb, Na, Mg, Cl, F, Cr, Cd, Cu, B, As, Ba, Mo, Se, Zn, total N, TOC, TVOC, PCB, SO_4, Ni, (24)	2,304	2,304	4,608
Lysimeter	3 places, 2 depths (150 & 300 cm became 50, 100, & 300 cm)	Composited at each depth 2x/month, 24 times	48	Same as irrigation water (3)	144	144	288
		Monthly composited at each depth	24	Same as irrigation water (24)	576	576	1,152
				Total water and moisture	3,990	3,990	7,980

(continued)

TABLE 3 (continued)

Sample Type	Location	Sampling Frequency	Number of Samples	Constituents for Analysis	Number of Analyses per Site Test	Control	Total
Crops – lettuce and tomatoes	4 sets of 5 composited plant samples of leaves and fruit	1 each	8	Coliform, total and fecal	16	16	32
			8	NO_3-N, Ca, P, K, Na, Mg, Mo, Pb, Cr, Cd, Cu, B, Fe, As, Ba, Cl, S, Mn, Se, Zn, (20)	160	160	320
				Total crops	176	176	352
				Total analyses	5,552	5,552	11,104

- Climatic data (wind, temperature, precipitation, etc.).
- Hydrogeology.
- Soil characteristics.
- Crop type, rotation, planting and harvesting dates, and yield.
- Farm worker health data.
- Crop market factors.

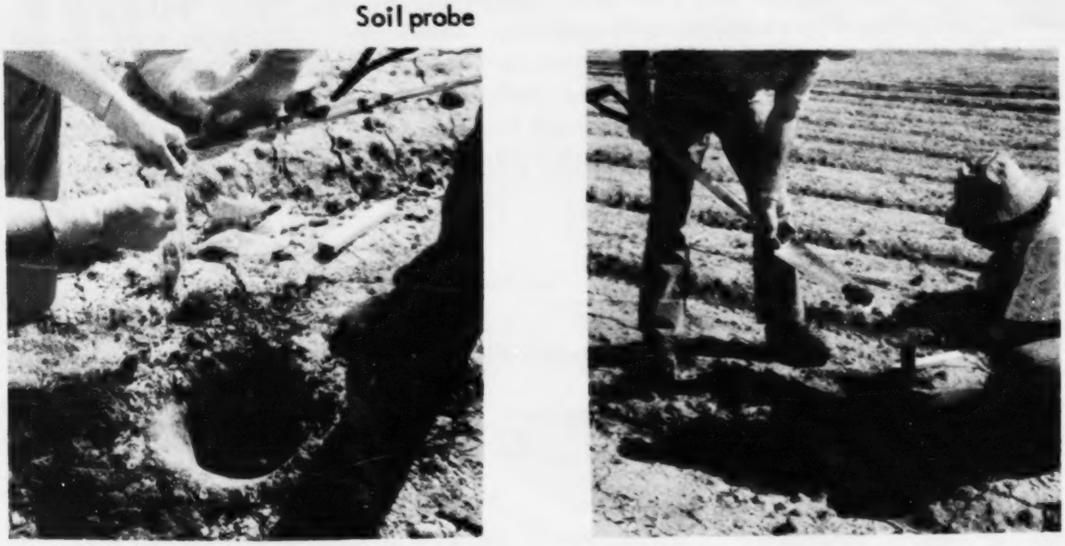
These data are presented in Appendix A, "Site Description."

SOIL SAMPLE COLLECTION

In accordance with the final program, soil samples were obtained prior to the first crop planting at the beginning of the monitoring, and after the last crop was harvested at the end of the monitoring. Soil samples were taken at seven depths (1, 3, 10, 30, 100, 200 and 300 cm) and analyzed for the physical, chemical, and biological parameters indicated in Table 3. Ten sampling points were distributed uniformly throughout the area of each site for the shallow sampling (up to 100 cm). Deep samples (200 and 300 cm) were taken at two locations at each site where the drill rig and backhoe had access. Appropriate soil collection procedures were followed for biological, physical and chemical analyses as detailed below and illustrated in Figure 3.

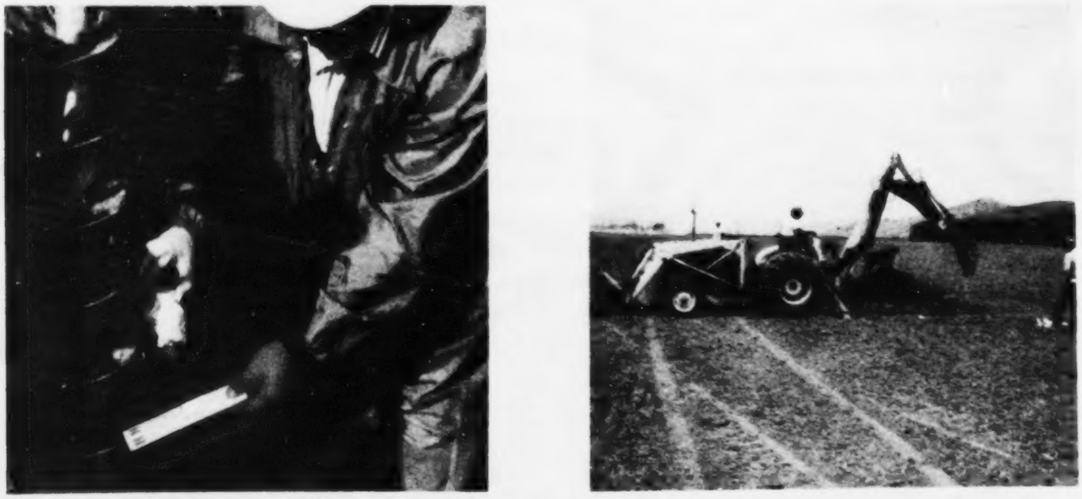
Biological and Chemical Sample Collection

Obtaining uncontaminated soil specimens for biological analysis proved to be a complex sampling procedure. Several methods were used to collect "clean" samples from seven depths at each location. Taking soil samples with a 15 cm diameter auger drill was found to be unacceptable due to the difficulty of preventing soils of different depths from intermixing during the collecting operation. Soil samples taken with a stainless steel, manually-operated probe were also subject to contamination during extraction. Trenching with a backhoe was found to be an effective means of obtaining good clean samples at the test and control sites. Hence, 3-meter deep trenches were excavated at the desired locations and the selected depths were measured down the side wall of each trench. A disposable sterile spatula was used to scrape away approximately 2 cm of the exposed trench side wall to uncover the undisturbed soil. Next, the uncontaminated soil was transferred from inside each side wall location into a sterilized sample container using a second sterile spatula. During the sampling at the Camarillo site, it was determined that an undisturbed sample could also be easily obtained by removing a bucket of soil from the desired depth with a mechanical backhoe, and then taking the undisturbed biological soil specimen from the center of an unbroken clod of soil excavated at the desired depth.



a. Shallow soil sampling with soil probe.

b. Shallow soil sample collection with sharpshooter shovel.



c. Collecting deep soil sample from drill auger.

d. Collecting deep soil sample from backhoe excavation.

Figure 3. Soil sampling at the test site.

Once taken, samples were transferred immediately to an ice chest refrigerated at 4 to 8° C where they remained until analyzed. Generally, all samples were composited in the laboratory and analyzed in accordance with recommended methods referenced in Appendix B. Biological examination was started within 24 hours after sample collection. Because unstable chemical compounds were also subject to time constraints, soil specimens for chemical analysis were ordinarily collected at the same time as the biological samples, and in the same manner.

Physical Samples

Soil samples were also collected and physically analyzed for their density, moisture content, organic content, hydraulic permeability and particle size distribution. Shallow samples, 30 cm or less, were collected with hand tools. Deeper sampling employed a 15-cm diameter powered auger drill. Use of the drill, and standard methods for determining physical properties are further described in Appendix B.

LYSIMETER SAMPLES

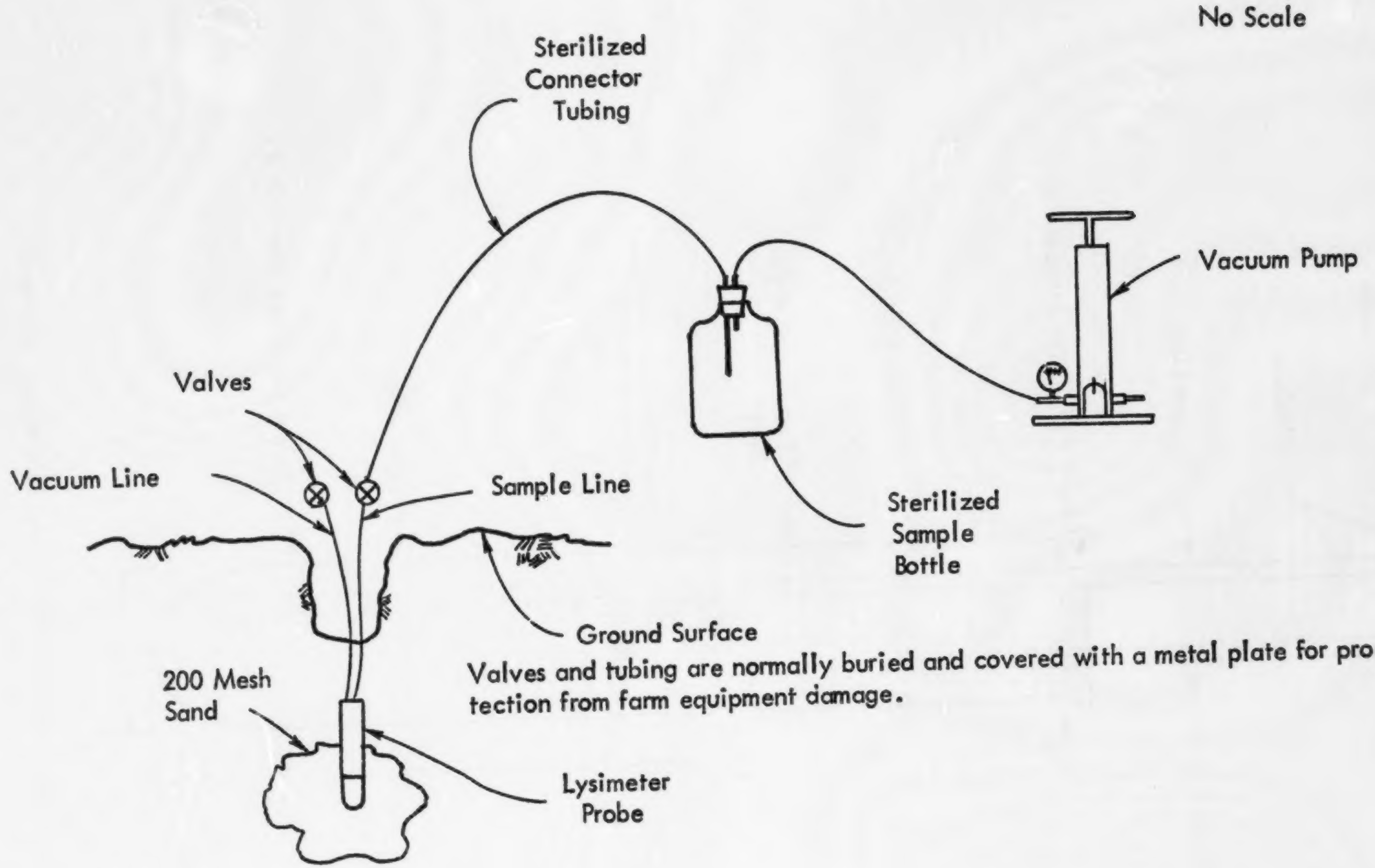
The leachate sampling program was designed to provide percolated water data at specific depths to allow comparison of chemical and biological balances and changes at both the test and control farm sites. The leachate was analyzed for the constituents itemized in Table 3. Figure 4 shows a schematic of the leachate sampling system.

Lysimeter Design

The lysimeters installed at the study sites were constructed using 60-cm sections of PVC, Class 125 psi, 5-cm O.D. pipe as shown in Figure 5. A 7 cm long by 4.7 cm diameter ceramic porous cup was attached to one end of the lysimeter probe pipe. The cups had a wall thickness of 0.23 cm with pore openings in the 1-2 μ range. The other end of the lysimeter probe pipe was fitted with a number 10 rubber stopper through which two 0.6-cm O.D. polyethylene tubes were extended. One polyethylene tube extended the length of the lysimeter probe and was used to remove collected leachate samples. The other tube terminated 1 cm below the rubber stopper and was used as a vacuum inlet for the lysimeter. Both tubes were fitted with gas-tight valves which controlled the internal vacuum and leachate sample flow.

Field Development

A series of field development tests were first carried out to determine the optimum vacuum conditions for the lysimeters. Figure 6 shows the amount of vacuum suction that was needed to extract leachate from Camarillo soils as a function of their percentage of soil moisture. The soil moisture percentages in the agricultural topsoil were high enough for leachate collection, using a vacuum lysimeter, only immediately following irrigation or rainfall. The use of falling vacuum lysimeters avoided the expense of providing a continuously operating vacuum pump. This,however, necessitated embedding the porous


No Scale
Sterilized
Connector
Tubing
Vacuum Pump
Valves
Vacuum Line
Sample Line
Sterilized
Sample
Bottle
Ground Surface
200 Mesh
Sand
Lysimeter
Probe

Valves and tubing are normally buried and covered with a metal plate for protection from farm equipment damage.

Figure 4 . Sterile leachate sampler system schematic.

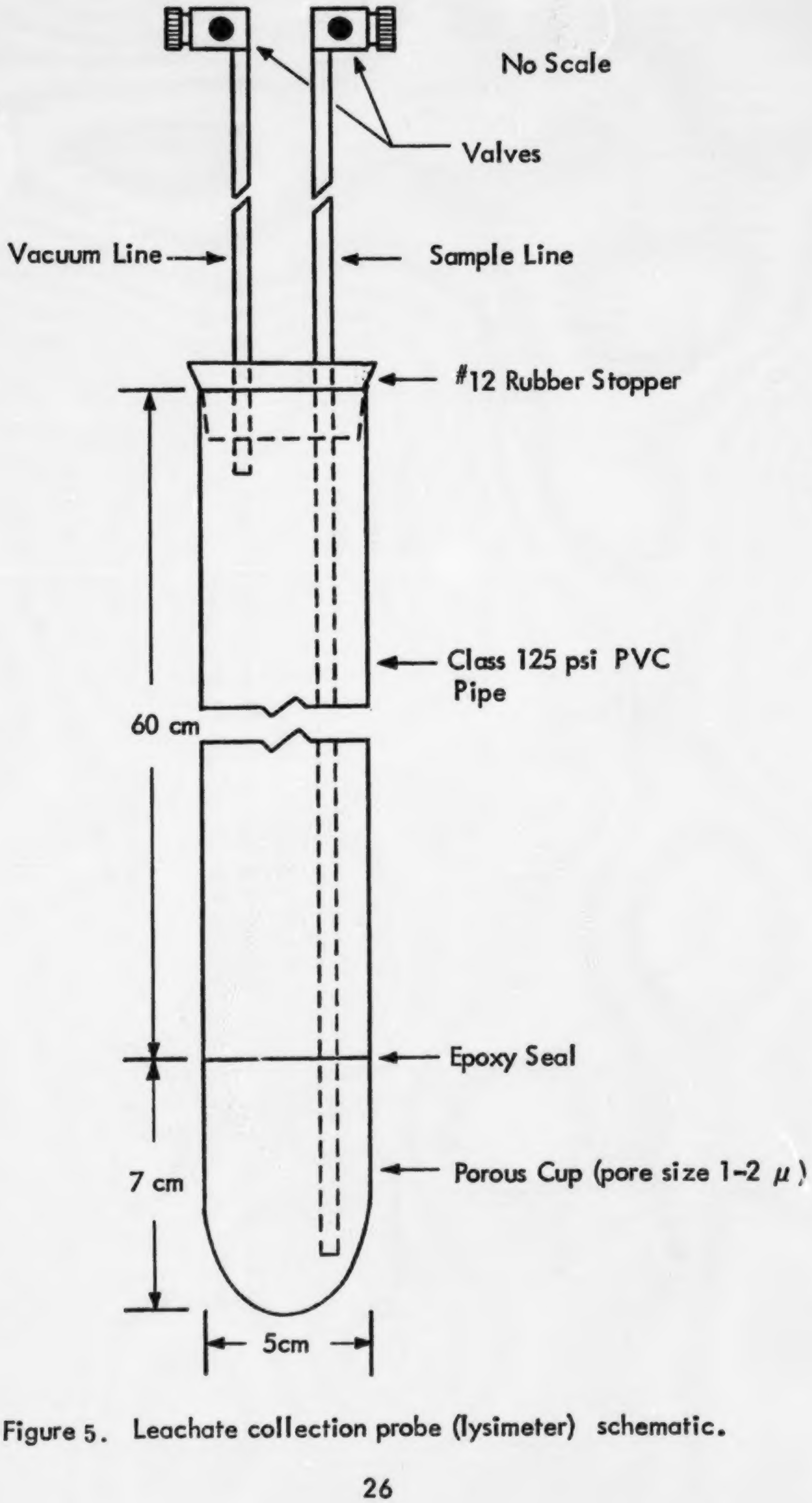

No Scale
Valves
Vacuum Line
Sample Line
#12 Rubber Stopper
Class 125 psi PVC Pipe
60 cm
Epoxy Seal
7 cm
Porous Cup (pore size 1-2 μ)
5cm

Figure 5. Leachate collection probe (lysimeter) schematic.

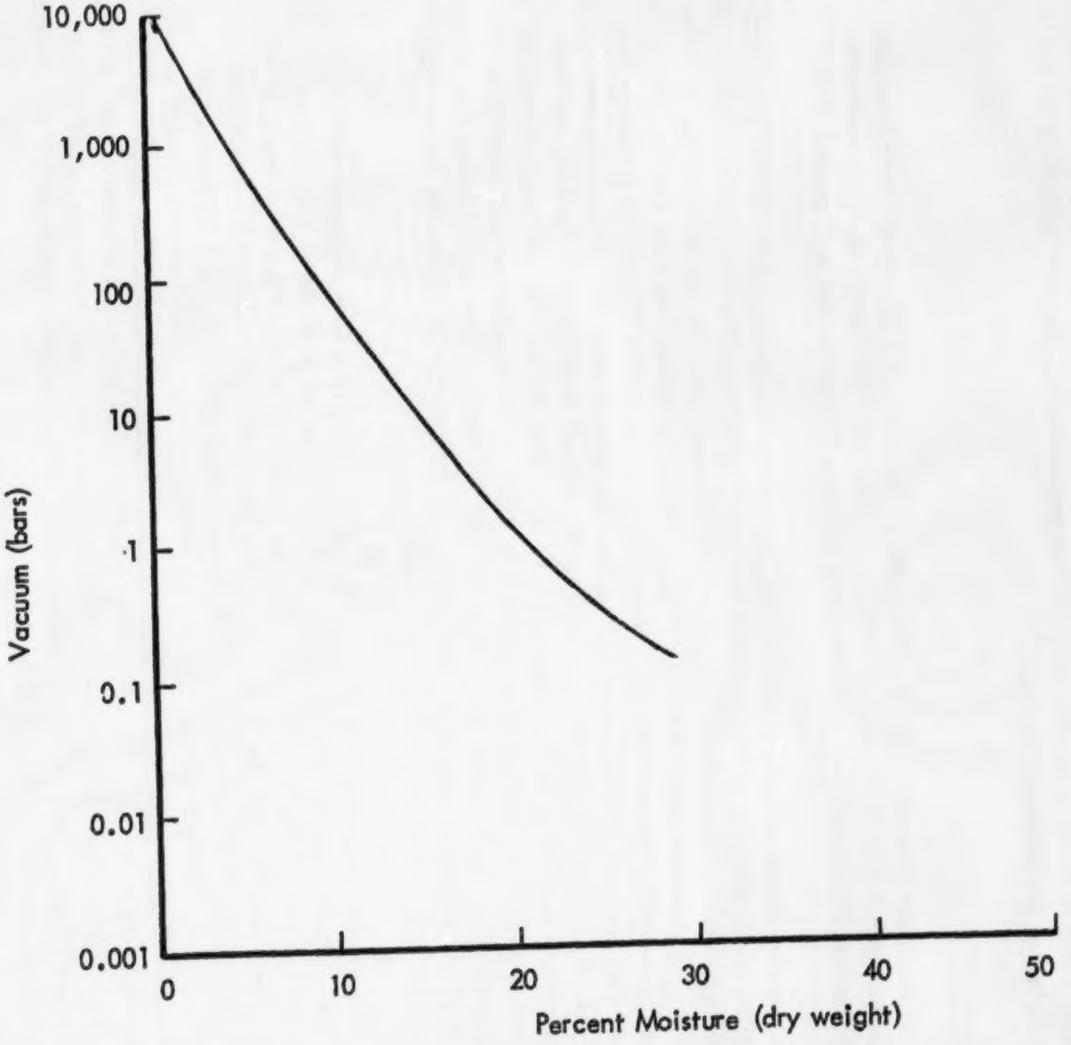


Figure 6. Lysimeter probe leachate collection and moisture release curves.

cup in a slurry of 200-mesh sand. The sand slurry encasement served two purposes: it transported moisture by capillary action into the lysimeter cup, and it helped prolong the vacuum duration.

It was determined that an applied vacuum of over 630 mm of mercury (0.838 bars) could collect moisture for 36 hours. The lysimeter vacuum loss curve is illustrated in Figure 7. The soil moisture profile changed as a function of time between water applications as illustrated in Figure 8. Thus, by applying a 36-hour vacuum to the lysimeters within one to three days after irrigation or precipitation, the peak soil moisture could be sampled at the different depths.

Installation

Lysimeters were installed at soil depths of 50, 100, and 300 cm at three locations within each field, as illustrated in Figures 9 and 10. The locations of the lysimeter probes are illustrated in Figures 11 and 12 for the Camarillo test and control sites.

For the 300 cm deep lysimeter probe, a hole was excavated with a heavy duty mechanical auger drill rig or backhoe and the hole bottom was filled to a depth of 20 cm with 200-mesh sand slurry. Then, the probe was inserted, ceramic cup downwards, into the center of the slurry bed. After placing the lysimeter probe, the hole was backfilled and compacted with layers of the excavated soil to 60 cm below the ground surface. The sampling and vacuum lines were then coiled and placed beneath a protective metal plate at the 60 cm depth to protect against farm equipment damage, and the hole was then completely backfilled with native soil. Finally, the topsoil was also well-compacted to prevent water from bypassing or channeling down into the lysimeter and causing an unrepresentative short-circuited leachate sample. Care was taken to minimize the alteration of the physical, chemical, and biological characteristics during the backfilling and to avoid interference in the farm operations.

The shallow lysimeters (50-and 100-cm depths) were installed somewhat differently. A trench approximately 90 cm long was excavated by hand shovel at the selected location to a depth of 50 cm. At one end of the trench, a hole was dug to a depth of 100 cm. The lysimeter was then installed in this hole following the backfill procedure for the 300-cm depth probes described above. A second lysimeter, with its porous cup pointed downward and towards the 100-cm lysimeter probe, was then installed at an angle of 10° with respect to the horizontal in the original trench. The sample and vacuum lines were run back to the other end of the trench and covered with a metal plate. Next, the trench was completely backfilled. Lysimeters were evacuated after their initial installation. The initially collected water, which was introduced with the 200 mesh sand slurry, was extracted and disposed.

Sampling Procedure

Initially, the lysimeter probes were evacuated following each field irrigation or

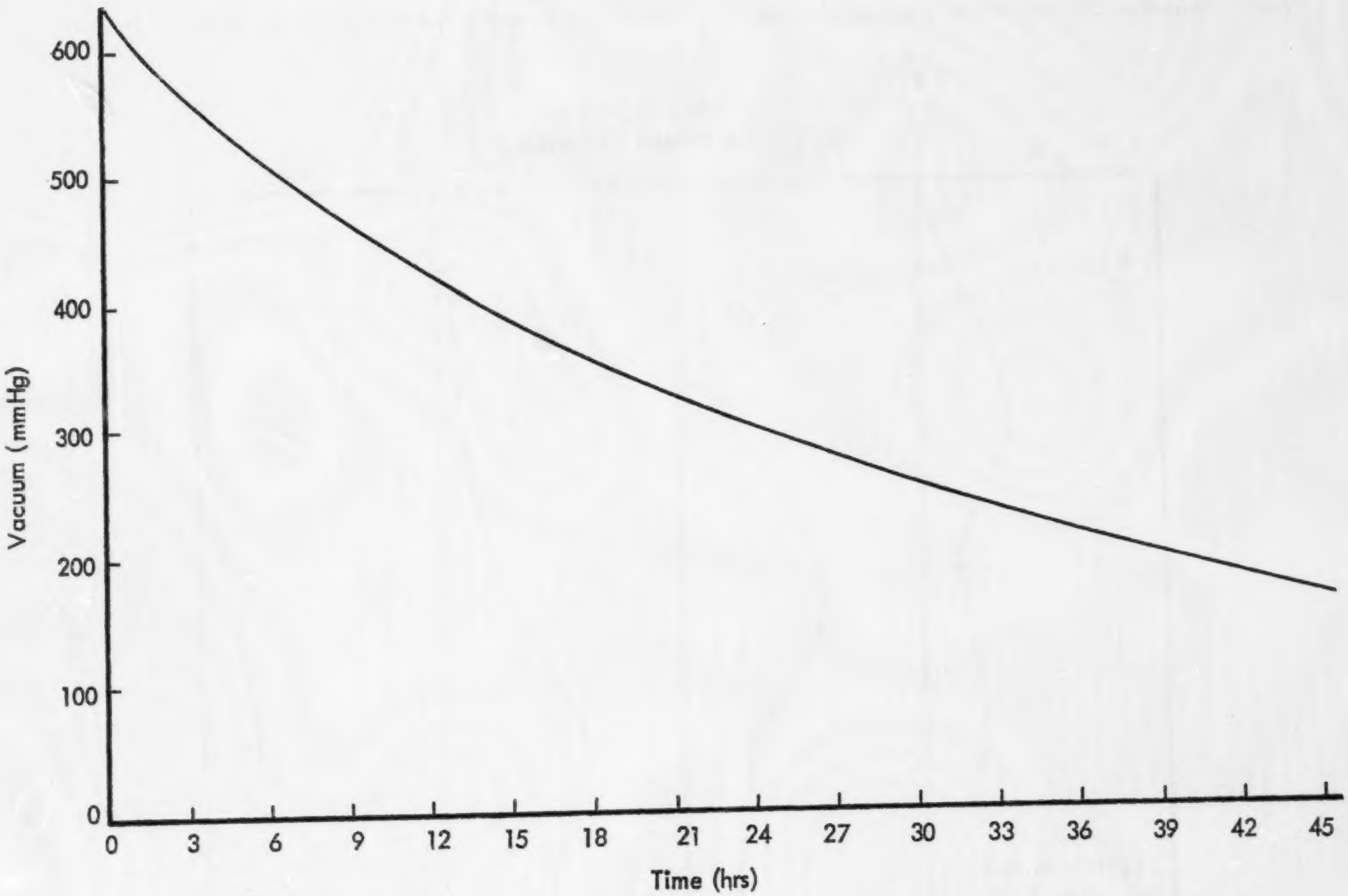


Figure 7. Falling vacuum lysimeter, vacuum dissipation with time.

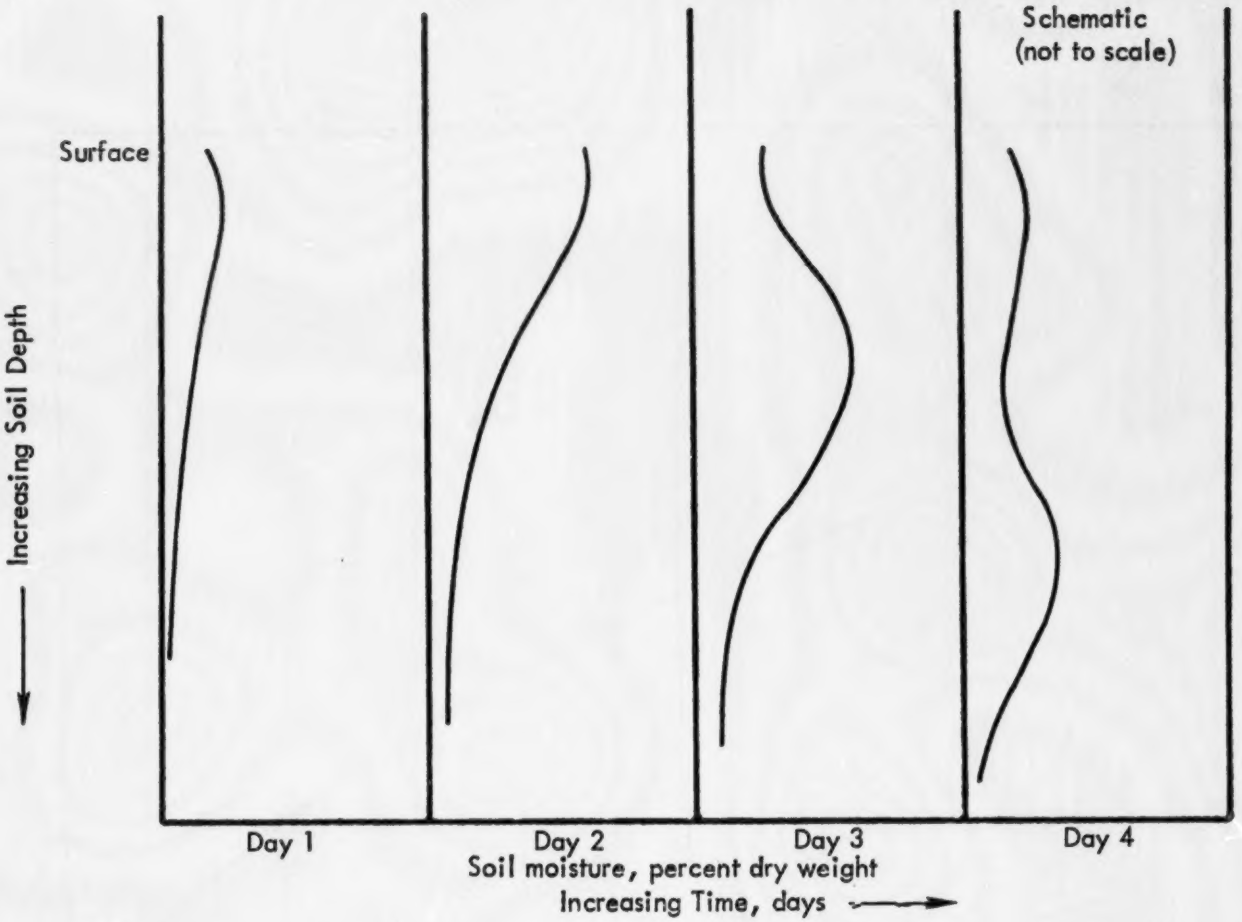
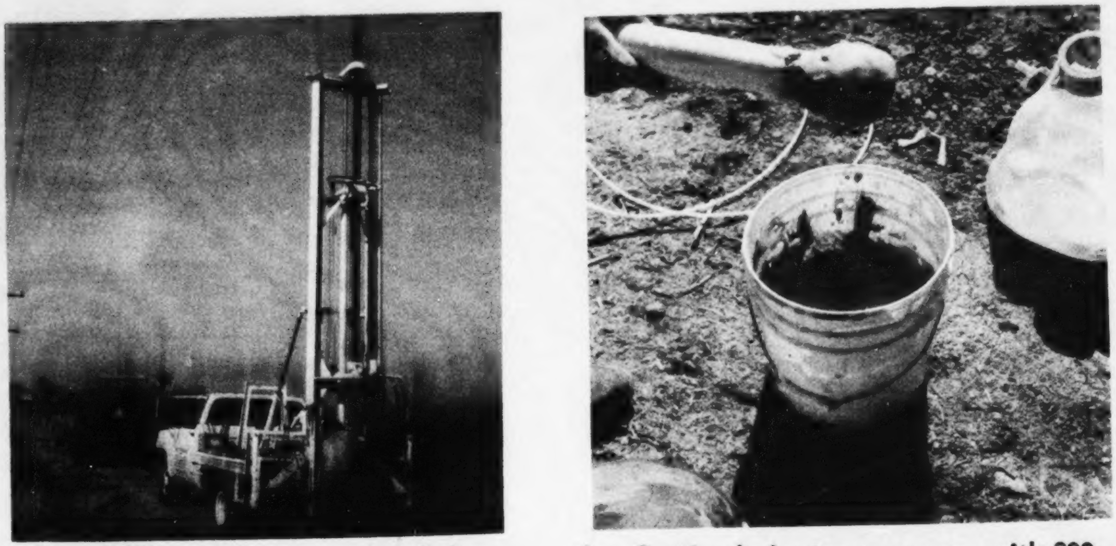
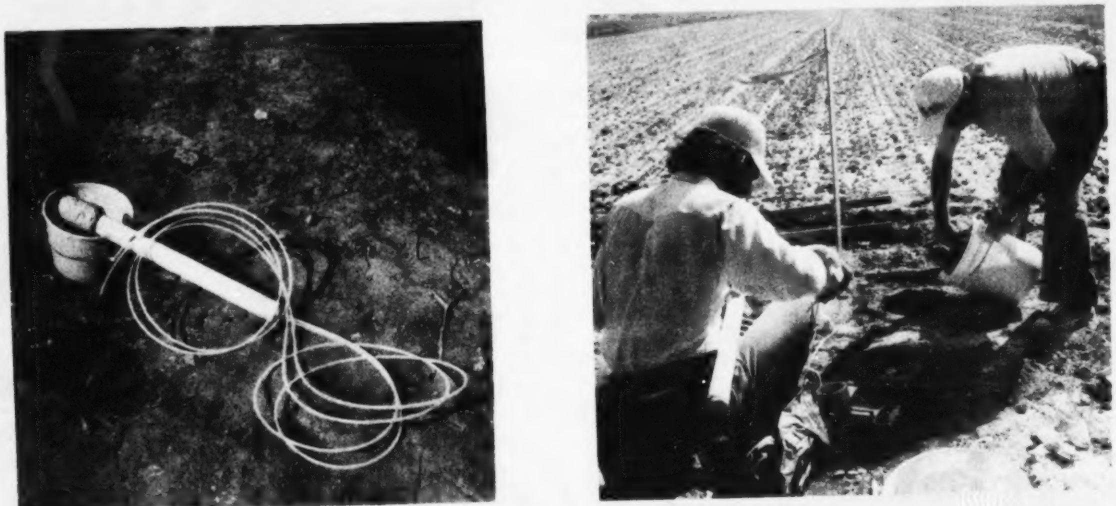

Schematic
(not to scale)
Surface
Increasing Soil Depth
Day 1
Day 2
Day 3
Day 4
Soil moisture, percent dry weight
Increasing Time, days

Figure 8. Idealized soil moisture profile as a function of time after an application of surface water.



a. Drilling 6" diameter borehole.

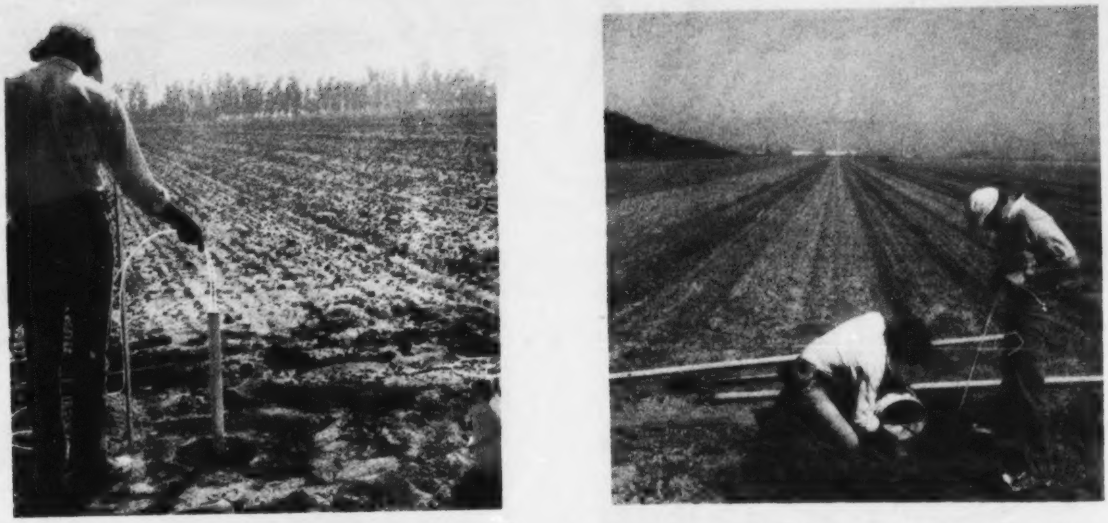
b. Coating lysimeter porous cup with 200-mesh sand slurry.



c. Lysimeter ready for placement in subsoil.

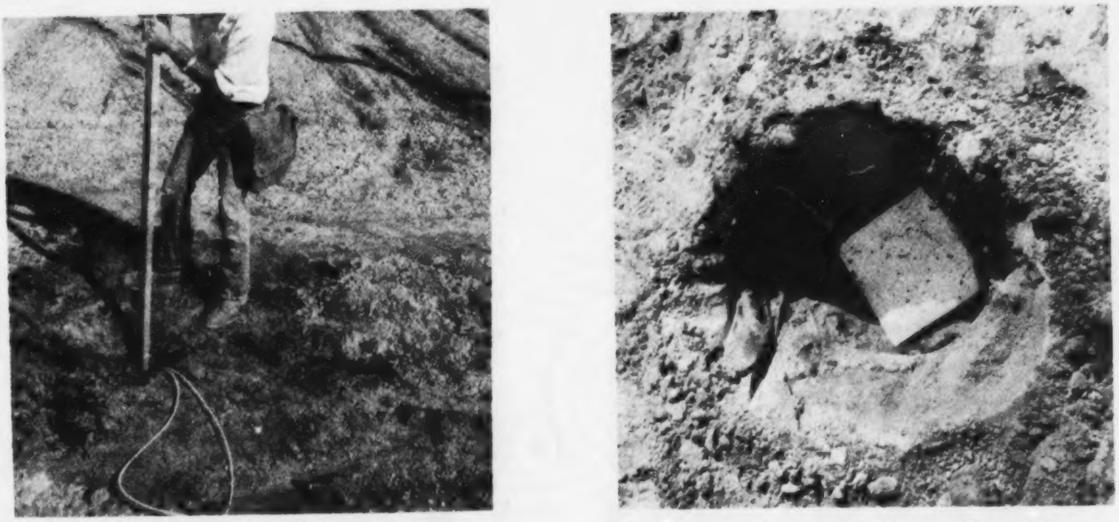
d. Adding 200-mesh slurry sand bed to bottom of lysimeter borehole.

Figure 9. Lysimeter installation.



a. Inserting lysimeter into borehole.

b. Backfilling hole with 200-mesh sand and soil.



c. Tamping backfill top soil.

d. Protective metal plate offset from lysimeter and covering coiled sample lines.

Figure 10. Lysimeter installation.

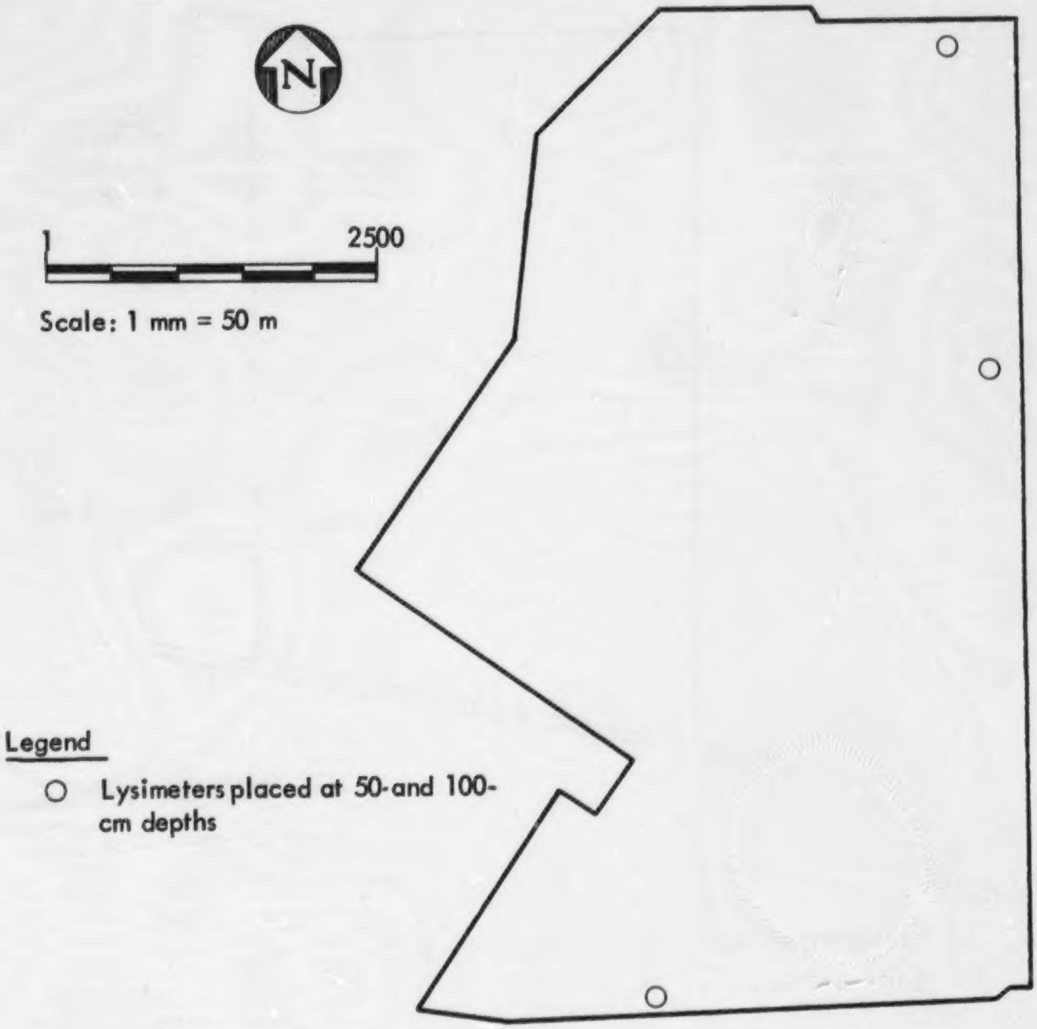

N
1
2500
Scale: 1 mm = 50 m
Legend
○ Lysimeters placed at 50-and 100-cm depths

Figure 11. Control site lysimeter locations.

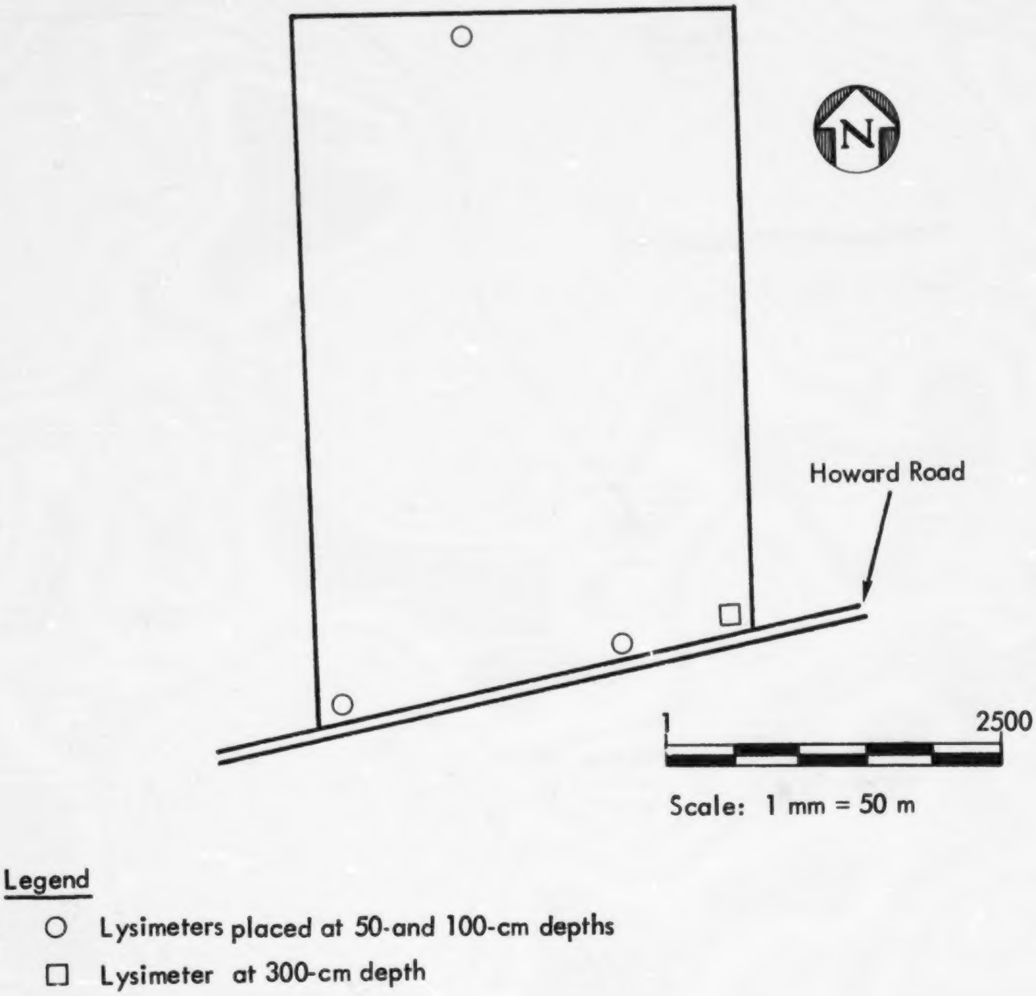

N
Howard Road
1
2500
Scale: 1 mm = 50 m
Legend
○ Lysimeters placed at 50-and 100-cm depths
☐ Lysimeter at 300-cm depth

Figure 12. Test site lysimeter locations.

natural precipitation to maximize the amount of leachate collected. Within two days of evacuation, the lysimeters were then sampled to remove all the collected leachate. To avoid non-representative reactions from occurring and to prevent reabsorption of the sample by the soil as the vacuum dissipated and the 200-mesh sand encasement dried, the leachate sample was allowed to remain in the probe no longer than two days. Sterile collection procedures were used for all the samples. The leachate removal apparatus was sterilized each time before use to prevent contamination of bacteriological samples. Leachate samples were then removed via the lysimeter sampling probe using a hand-operated vacuum pump as depicted in Figure 4. After sampling, the rubber stopper on the sample bottle was replaced with a sterile lid, each probe was re-evacuated, and the sample lines were reburied to protect against damage by farm equipment. Leachate samples were refrigerated at 4° C while in transit and up until time for the laboratory analyses. Bacteriological tests were started within 24 hours after the samples were collected. As the study progressed, the lysimeters were sampled and evacuated at two-week intervals. Occasionally, the shallow lysimeters were damaged during field plowing and required replacement. Figure 13 illustrates the field sampling.

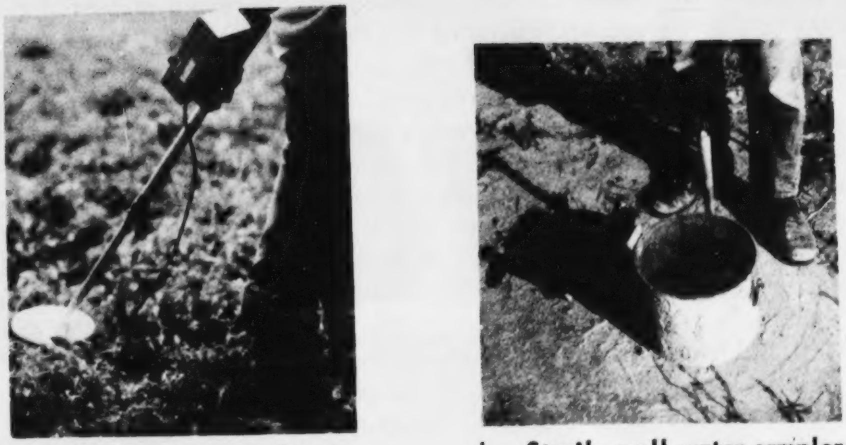
Other investigators have reported erroneous nitrate and phosphate concentrations from analysis of leachate collected with porous ceramic cup lysimeters (2). Apparently, NO_3 and PO_4 ions can be adsorbed onto the ceramic cup walls as they pass through. This effect was avoided by pretreating lysimeters in nitrate and phosphate solutions to reduce possible adsorption need. At the Camarillo site, a number of lysimeters were installed which proved unproductive, probably because high soil porosity provided little retained moisture. The amount of leachate collected from these lysimeters was increased by using a much larger volume of 200-mesh sand bedding than the original lysimeters had. The standard sand volume was increased approximately threefold to about 4 cubic decimeters for each ceramic lysimeter cup.

IRRIGATION WATER

Undesirable constituents may be introduced into the soil and groundwater via the application of irrigation water. Analyses of this water provided significant baseline data from which to quantitatively determine the important constituents. The analyzed constituents are listed in Table 3. The sampling locations are shown on Figure 14.

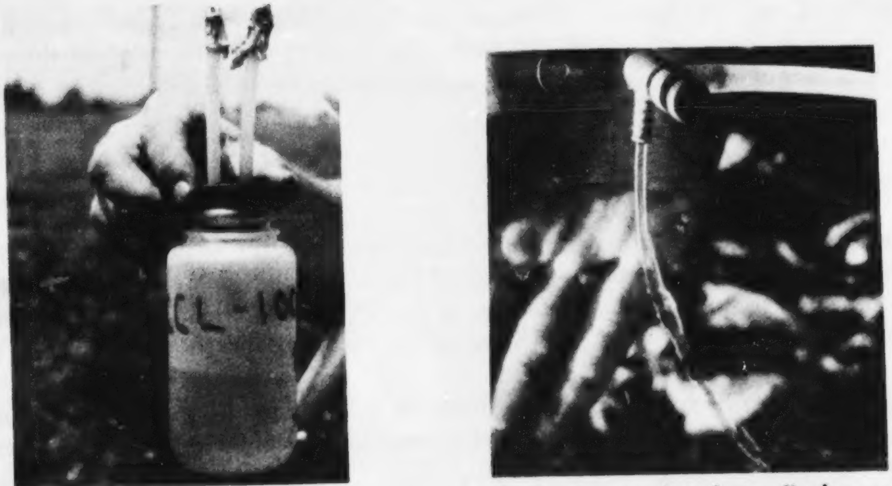
Effluent samples from the Camarillo wastewater treatment plant were collected daily by means of a 24-hour automatic composite sampler positioned between the chlorination contact basin and the irrigation holding pond.

Three flow-rated portions of the daily composited samples were composited into three sample bottles for a period of two weeks and stored at 4-8° C by refrigeration. The control site was irrigated with combined deep well (on-site) water and city water. Every two weeks a grab sample of the city water was obtained and when the well was operated. Each grab sample was subdivided into three sample bottles. Each sample was then preserved in the same manner as the effluent bi-weekly composite sample. One sample



a. Metal detector to locate buried lysimeter.

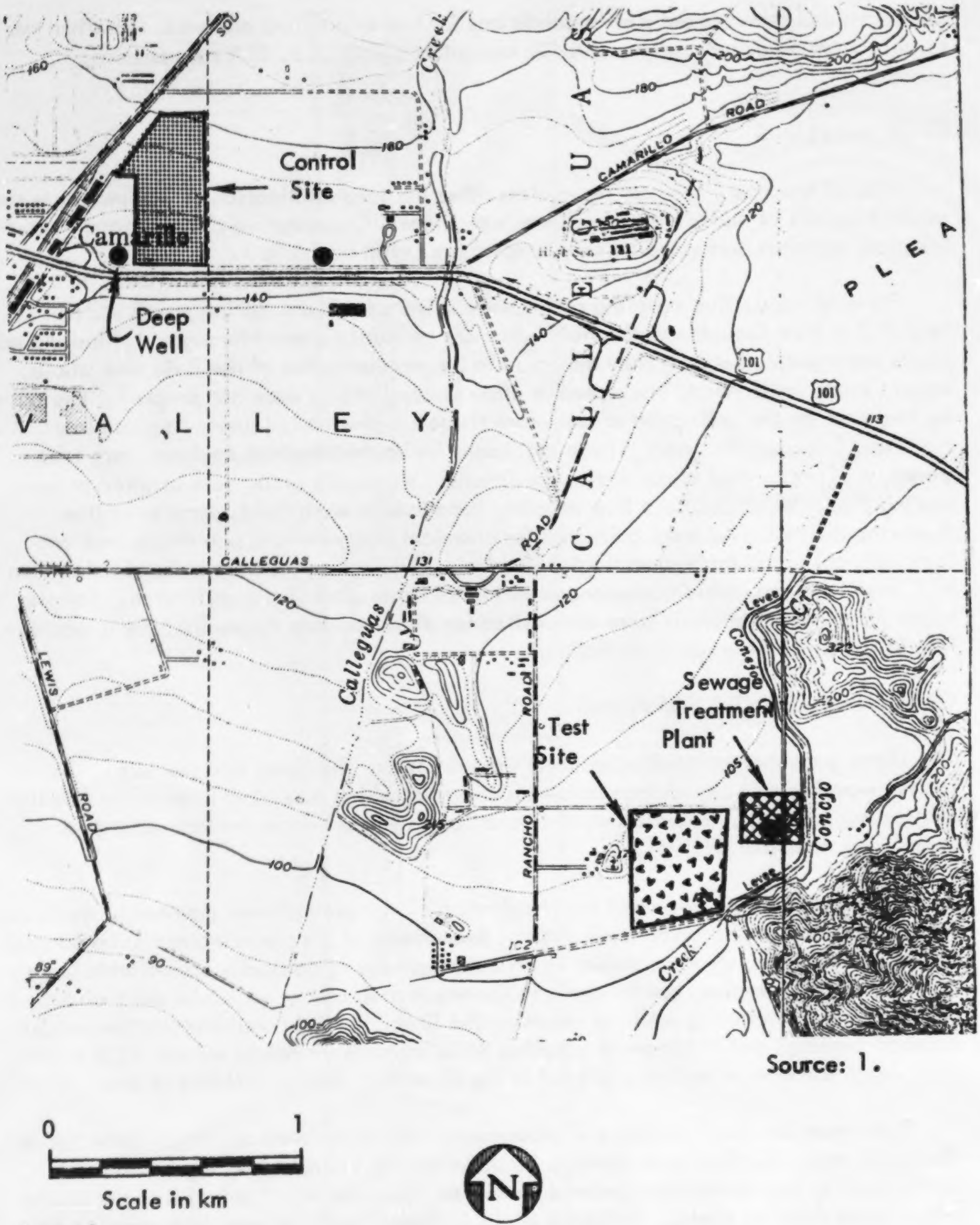
b. Sterile well water sampler.



c. Sterile lysimeter sampler.

d. Lysimeter leachate discharge.

Figure 13. Field sampling.


Control Site
Camarillo
Deep Well
V A L L E Y
C A L L E G U A S
P L E A
CAMARILLO ROAD
101
113
140
160
180
200
120
CALLEGUAS ROAD
131
Calleguas Creek
LEWIS ROAD
RANCHO ROAD
Test Site
Sewage Treatment Plant
Conejo Cr.
Levee
322
105
102
100
90
400
Creek
0
1
Scale in km
N

Source: 1.

Legend

● Irrigation water sampling point

Figure 14. Irrigation sampling locations.

was taken and stored under sterile conditions for bacteriological analyses; the other two samples were acidified and preserved in accordance with U.S. EPA recommended practices.

CROP SAMPLING

One of the most important parameters affecting land application of wastewater is the possible uptake of undesirable constituents by crops. Quantitative chemical and bacteriological analyses performed on crop samples are listed on Table 3.

For each crop, five sampling points were selected. The sampling points were at least 7.5 m from the edge of the field and were uniformly spaced throughout. Individual plants were sampled only if they appeared to be representative of the field as a whole. Large, small, malformed, discolored or other unusual plants were not sampled. The procedure used for the collection of test plant tissue samples varied depending on plant types and intended analyses. Tissue specimens for bacteriological analyses were taken, stored, and transported under sterile conditions. Vegetable crops were sampled at harvesting time. At each of the five sampling locations in each field, samples of five flowers and five leaves were collected for chemical analysis, and one flower and one leaf were collected for bacteriological analysis. These samples were maintained at 4 to 8° C until analysis, which commenced within 24 hours after tissue collection. Samples taken for chemical analysis were composited for digestion (see Appendix B for a description of the plant tissue analysis method).

GROUNDWATER WELL SAMPLING

Three groundwater monitoring wells were drilled at the Camarillo test site. The objective was to assess any change in the groundwater which may have been caused by the infiltrating leachate. Table 3 lists the constituents whose concentrations were determined from chemical analysis.

The criteria which governed the installation of the groundwater monitoring wells were: to place the wells upstream,on-site and downstream of the groundwater aquifer for each test or control site where possible; to drill through stratigraphically identifiable formations and obtain samples, and to avoid faults where drainage water could short-circuit directly to the monitoring well; to minimize the impact of field well installation procedures on farming; and to construct sampling wells which were not to exceed 30.5 m in total depth with the lower 3-6 m placed in the uppermost aquifer yielding at least 15 lpm.

Data were obtained on soils and groundwater during the well drilling. In the Camarillo study area, the sites were found to be underlain by interbedded clays, silts, and water-bearing fine-to-medium grained sands (see Appendix A). Table 4 lists the depths of the water-bearing strata. The slope of the hydraulic gradient was determined to be approximately one percent toward the northwest (see Figure 15).

TABLE 4. MONITORING WELL DEPTHS

Site	Well	Water-bearing Strata	Depths (m) Perforated Casing	Static Water Level	Water Elevation, M.S.L.
Camarillo	T-1	5-6, 14 - 15	5 - 14	5[a]	27[a]
	T-2	16 - 20	2 - 18	11[b]	23[b]
	T-3	15 - 16	2 - 15	10[c]	21[c]

[a] 2/24/77.
[b] 2/28/77.
[c] 4/8/77.

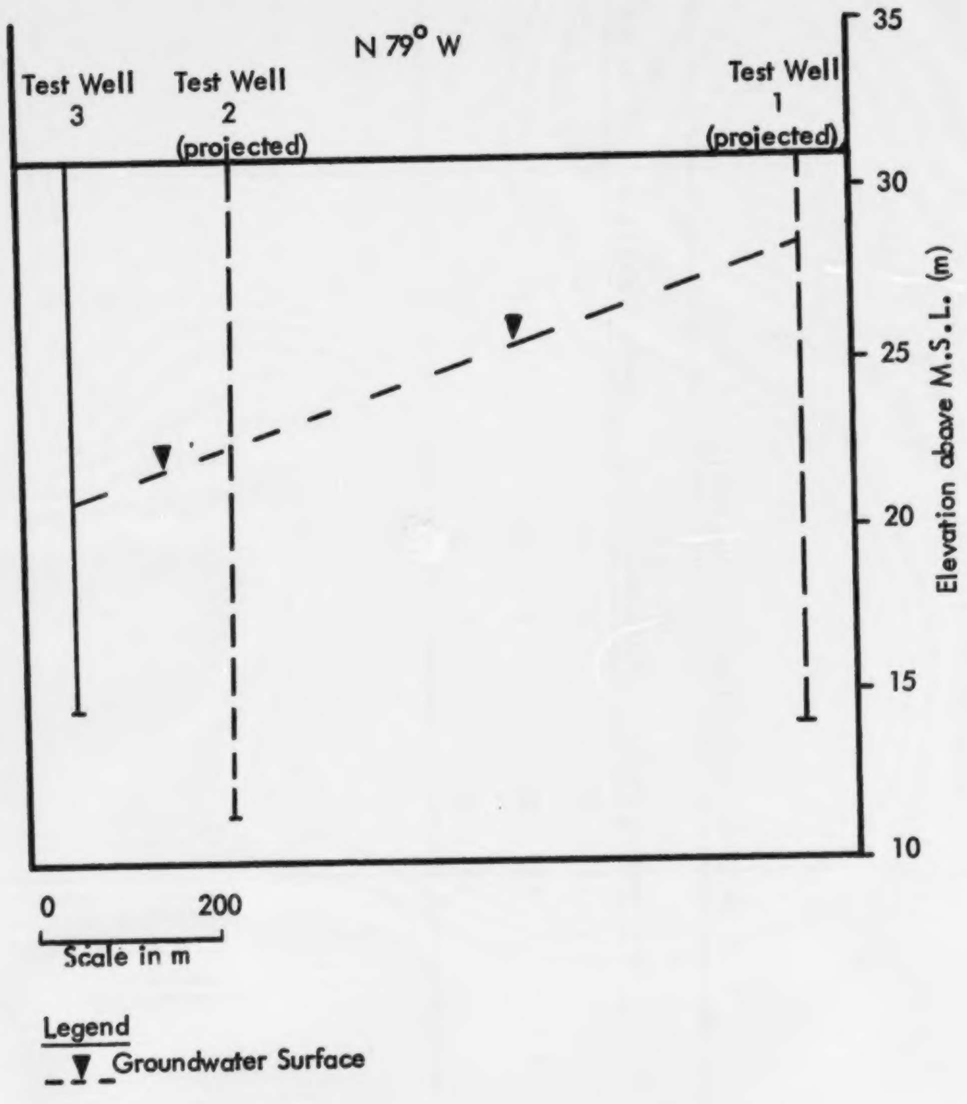
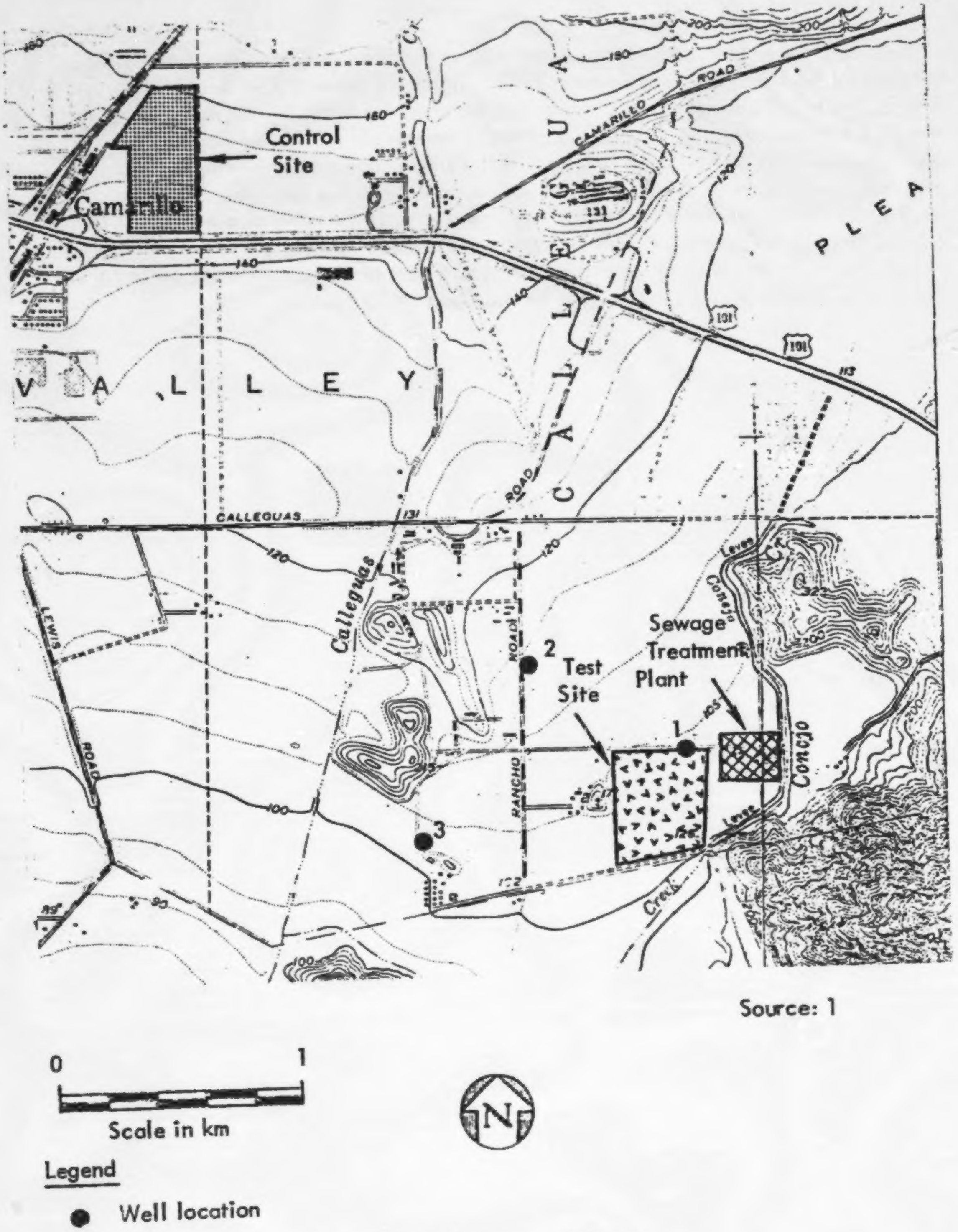

N 79° W
Test Well 3
Test Well 2 (projected)
Test Well 1 (projected)
35
30
25
20
15
10
Elevation above M.S.L. (m)
0
200
Scale in m
Legend
Groundwater Surface

Figure 15. Idealized cross-section showing wells and groundwater levels.

Using the cable tool method, three wells were installed in Camarillo, California between mid-January and early March 1977. Figure 16 shows the well locations. The first well was drilled with an open hole, but water in the formation caused caving which slowed the installation. It was then decided to encase all further holes with 20 cm diameter steel as they were drilled to speed up the work. Some bentonite clay drilling mud and a small amount of cement were employed to keep the first well hole from caving. Very little drilling mud and no cement were used to drill the other two wells. At the control site, in April,1977, a well was drilled to a depth of 34 m without encountering water; hence, it was abandoned and backfilled. Other test wells were not drilled since the groundwater depth was believed to be too deep (> 30 m).


Control Site
Camarillo
CAMARILLO ROAD
U
A
PLEA
V A L L E Y
C A L L E
CALLEGUAS
ROAD
Cr.
180
160
140
120
100
90
200
131
101
113
105
322
Calleguas
LEWIS
ROAD
RANCHO ROAD
2
Test Site
Sewage Treatment Plant
1
3
Levee
Conejo
Cr.
Creek
0
1
Scale in km
N
Legend
● Well location

Source: 1

Figure 16. Monitoring well locations.

SECTION 6

WASTEWATER IRRIGATION EVALUATION

After the field sampling and analytical planning schedule (described in Section 5) was established, the field sampling and laboratory analyses were initiated. The first soil and crop samples were collected during October and November, 1976. The groundwater monitoring wells were completed in March, 1977.

The comprehensive irrigation water, soil, crop, leachate, and groundwater test program was performed from March,1977 through February,1978. The final set of soil samples was taken between October and December, 1977. Plant samples were collected whenever the crops were harvested. The analytical results and the evaluation of the soil, plant, and water studies are presented in this section.

Statistical comparisons were made of the test and control site analyses to test for any significant differences between conditions at the two locations. Three basic data conditions existed between the test and control sites: (1) the data were significantly different, (2) the data were similar, and (3) the data were below the analytical method detection limits, inconsistent, or insufficient for determining any statistically significant difference or similarity. The following three statistical tests were employed to analyze the data as follows: difference of means by the hypothesis test (H-test) or the student t-test, and the difference in variability by the chi-square distribution test. Detailed explanation of these statistical tests may be found in any statistics textbook. Difference of means was generally the main criteria used for determining if significant differences existed between the test and control sites. The t-test was used as the criteria for significance in the difference of means whenever the number of samples were small (usually less than 10). The chi-square test was used to check the difference in variability between the test and control sites. The statistical tests were applied to complete the following data comparisons between the test and control sites:

- Control site irrigation water versus test site wastewater effluent.
- Leachate - comparison between test and control sites by depth.
- Groundwater - up to 30-meters depth below the ground surface; the on-site and downstream shallow groundwater samples were compared statistically for the test site. There were no control wells.

- Soils – test versus control sites for initial and final samples; initial versus final test and initial versus final control site samples.

The statistical analyses are presented in two data tabulations. The sample means, standard deviations, and statistical confidence levels (in percent) are given on one tabulation in Appendix E. The mean values and percentage difference in mean values between the test and control sites are summarized by confidence level categories for each type of sample and/or sample location in this section.

PHYSICAL CHARACTERISTICS OF SOILS

The physical soil characteristics, determined on boring samples taken in October, 1976, are presented in Table 5. Some accumulation of organic content (3.7 to 6.2 percent dry wt.) was found in the upper 30-cm depth on the test site but diminished to 1.8 percent dry wt., at lower sampling depths. The control site showed less organic content than the test site down to 100 cm (2.9 to 3.8 percent dry wt.), and greater moisture content at deeper depths (4.7 and 5.0 percent dry wt., respectively, at the 200-and 300-cm depths). Figure 17 graphically illustrates the change in organic content with depth.

Dry bulk densities were similar for the test and control sites, and generally ranged from 1.4 to 1.7 g/cc. Particle density was slightly less at the test site, from 2.42 to 2.78 g/cc, as compared to 2.70 to 2.83 g/cc for the control site.

The moisture content of the soils samples at the test and control sites generally increased with depth, as shown in Figure 18; differences in the curve shape were due to sampling at different time periods from the time moisture was last applied to the sites.

WATER ANALYSES

Graphical representations of the water analyses trends are presented in Appendix F. These figures illustrate the changes which occurred at the test and control site during the duration of the monitoring program for the irrigation water, the leachate from the lysimeters, and the groundwater from the wells. The biological and chemical results and statistical significance of the water analyses are discussed in the following paragraphs.

Irrigation Water Analysis

The statistical comparisons for the irrigation water are shown in Table 6. The constituents which were significantly higher in the test effluent, when compared to the control irrigation water, were total dissolved solids by 36 percent, boron by 270 percent, fluorides by 160 percent, and total organic carbon by 810 percent. The constituents contributing to the total dissolved solids were, generally, higher in the test effluent: chlorides by 125 percent, and sodium by 140 percent. The test effluent, however, was significantly lower in sulfate concentrations by 15 percent. As expected, the test effluent showed high-nutrient values in that total nitrogen, phosphates, and potassium were significantly greater by 330; 2,260; and over 265 percent, respectively. Nitrates, by 120 percent,

TABLE 5 . SOIL PHYSICAL CHARACTERISTICS[a]

Horizon (cm)	USDA Classification[b]	Particle Density (g/cc)	Dry Bulk Density (g/cc)	Hydraulic Conductivity (cm/sec x 10^{-5})	Moisture Content (% dry wt.)	Organic Content (% dry wt.)
Test						
1	Clay loam	2.58	1.5	1.96	8.5	5.2
3	Same as above	2.60	1.45	0.91	11.8	3.7
10	Same as above	2.74	1.4	10.8	14.1	6.2
30	Same as above	2.48	1.45	5.55	15.4	5.0
100	Loam, clay loam, sandy clay loam	2.78	1.45	2.9	16.3	3.6
200	Clay loam	2.66	1.5	0.44	19.5	3.4
300	Sandy clay loam, silty clay loam	2.42	1.7	1.8	20.6	1.8
Control						
1	Clay loam, sandy clay loam	2.70	1.57	2.33	7.0	2.9
3	Clay loam	2.78	1.55	3.05	12.0	2.5
10	Clay loam, sandy clay loam	2.78	1.55	2.55	13.6	3.8
30	Same as above	2.75	1.55	2.02	14.4	3.9
100	Clay loam	2.78	1.48	2.27	12.4	3.8
200	Silty clay, sand	2.83	1.46	20.0	13.9	4.7
300	Loam	2.83	1.12	27.3	15.4	5.0

---

[a] As averages of two locations within each field.

[b] Varying soil types are for different locations.

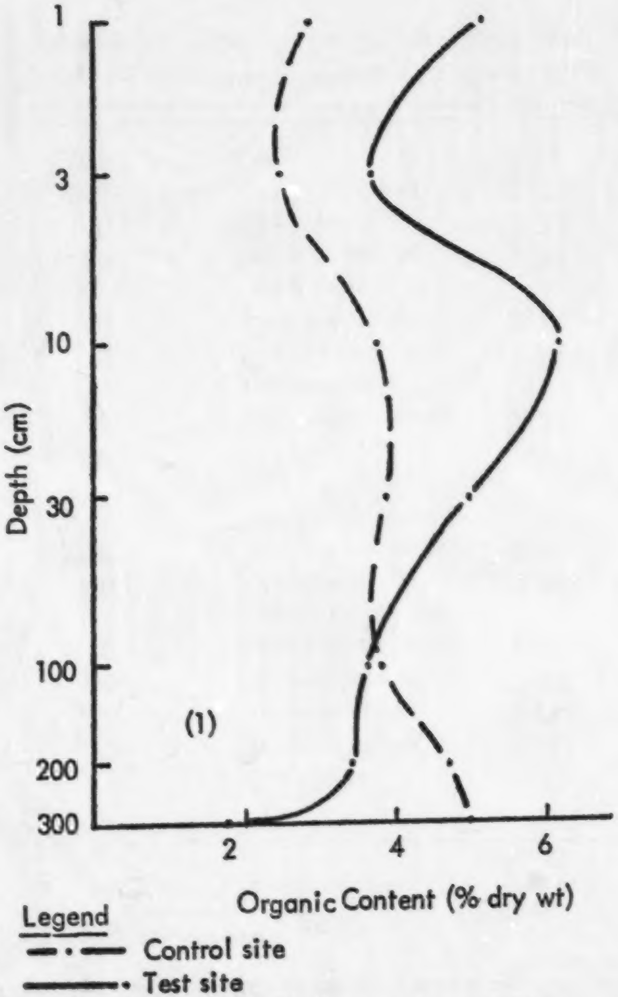


Figure 17. Soils organic content.

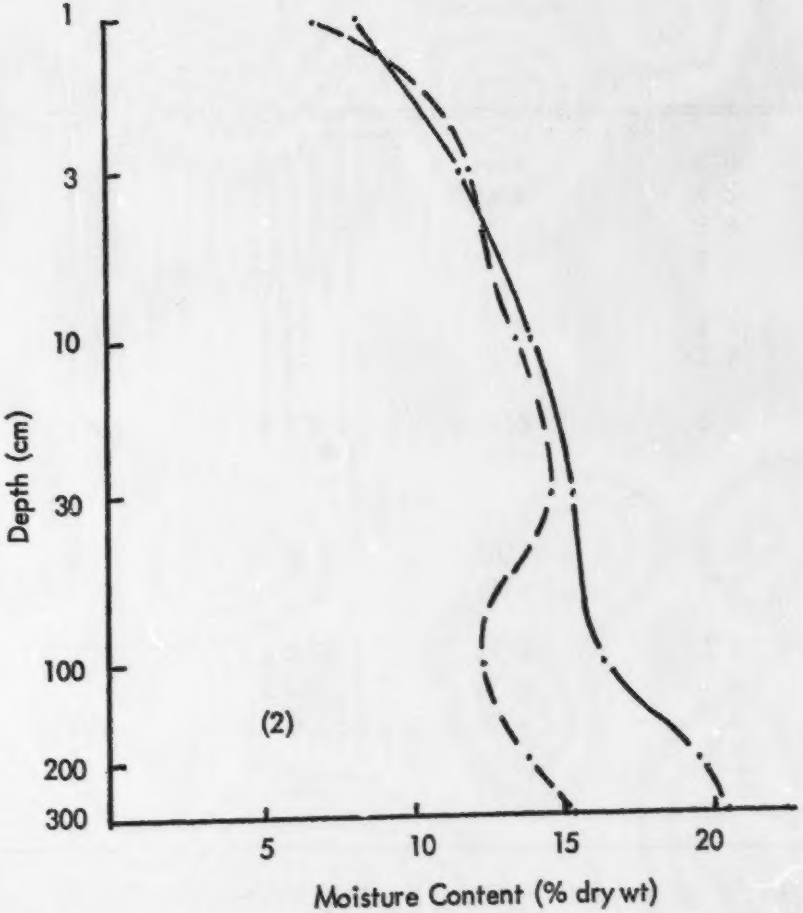


Figure 18. Soils organic content.

TABLE 6 . STATISTICAL SUMMARY OF IRRIGATION WATER

Constituent/ Form	Significance Level, Percent 96 - 99% Mean Values Control	Test	% Diff.	90 - 95% Mean Values Control	Test	% Diff.	Less than 90% Mean Values Control	Test	% Diff.	Indeterminable Results[a] Mean Value Control	Test	% Diff.
TC							< 2	57,000[a]	a			
FC							< 2	220[a]	a			
TDS	733	995	+ 36									
B	0.23	0.85	+270									
Cl	73	166	+125									
F	0.61	1.6	+160									
NO_3-N				2.1	4.6	+120						
TN	3.5	15.0	+330									
TOC	3.8	34.7	+810									
PO_4-P	0.5	11.8	+2,260									
SO_4	227	194	-15									
K	4.6	16.9	+265									
Na	88.4	212	+140									
Ca							49.6	54.7	+10			
Mg							40.1	33.7	-16			
Ba				0.17	0.08	-53						
Cd							0.01	0.02	+100			
Cr							0.03	0.02	-33			
Cu	0.13	0.06	-54									
Mo							0.10	0.11	+10			
Ni				0.05	0.10	+100						
Pb							0.08	0.05	-38			
Zn							0.07	0.05	-29			
As							0.01	0.01	0			
Se							0.01	0.01	0			

[a] Indeterminable because values were less than detection limit.

[b] The average value, in mg/kg, of results from seven depths.

[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a " – " sign) over the control.

and nickel, by 100 percent, showed probable differences (at the 90 to 95 percent confidence level) in being higher in the test irrigation water. Copper was significantly lower by 54 percent and barium was significantly higher (at the 90 to 95 percent confidence level) in the test effluent when compared to the control irrigation water. The total coliform and fecal coliform did not test statistically different between the test and control waters; however, the actual values show that the test effluent was much higher than the control water in coliform counts. The other constituents(calcium, magnesium, cadmium, chromium, molybdenum, lead, zinc, arsenic, and selenium) were not significantly different between the test and control sites. Thus, the constituent s comprising the total dissolved solids and the nutrients were the major contributors to the differences between the test and control irrigation waters. In general, the metal concentrations in the test effluent were similar to those found in the control irrigation waters. This is probably due to efficient control of metals in the sewage treatment process and the sewage being primarily of domestic origin.

Leachate Analysis

The leachate at the 50-cm depth showed no highly significant differences between the test and control sites (see Table 7), except for sulfate and potassium, which were about 75 percent higher and 38 percent lower at the test site, respectively. Those constituents showing probable significant differences at the 90 to 95 percent confidence level between the test and control sites were chlorides and lead, which were about 14 and 71 percent higher in concentration at the test site, respectively. During the second half of the test program, the differences in the lead concentrations as shown in Tables D-3, Appendix D, were insignificant. Fluorides and chromium also show some statistically probable differences; however, due to the low levels present in the samples and the detection limits of the analytical tests, the differences between the test and control site samples were insignificant. None of the remaining constituents showed any significant differences between the test and control site leachates.

At the 100-cm depth, the test site leachate was more significantly different from the control site, as shown in Table 8. In addition to the sulfate and potassium ions, which showed the same trends at the lower depth, boron was significantly higher by 57 percent at the test site, whereas, the test site was significantly lower than the control site in total dissolved solids by 23 percent, sulfates by 68 percent, calcium by 62 percent, and zinc by 58 percent. Nitrates and molybdenum, by 63 and 60 percent, respectively, were significantly higher (at the 90 to 95 percent confidence level) at the test site; whereas chlorides, fluorides, chromium, and lead were found significantly lower at the test site. There were no statistically significant differences between the test and control sites for the total and fecal coliform, total nitrogen, total organic carbon, phosphates, sodium, magnesium, barium, cadmium, copper, nickel, arsenic and zinc. In general, only boron, potassium, and nitrate were significantly higher in the test site 100-cm depth leachate. This was in contrast to the applied irrigation water in which the test effluent was also significantly greater in total dissolved solids, fluorides, total nitrogen, total organic carbon, phosphates, sodium, and copper.

TABLE 7 . STATISTICAL SUMMARY OF 50 CM LEACHATE

Constituent/ Form	Significance Level, Percent 96 - 99% Mean Values[b] Control	Test	%[c] Diff.	90 - 95% Mean Values Control	Test	% Diff.	Less than 90% Mean Values Control	Test	% Diff.	Questionable Results[a] Mean Value Control	Test	% Diff.
TC							4	7	+75			
FC							<2	<2	0			
TDS							1,996	1,741	-13			
B							0.74	0.89	+20			
Cl				217	247	+14						
F				1.1	0.75	-32						
NO_3-N							28.2	34.6	+23			
TN							27.5	36.6	+33			
TOC							27.2	26.1	-4			
PO_4-P							3.8	4.8	+26			
SO_4	434	267	-38									
K	15.4	26.9	+75									
Na							217	247	+14			
Ca							93.9	112	+19			
Mg							127	155	+22			
Ba							0.11	0.19	+73			
Cd							0.03	0.02	-33			
Cr				0.02	0.05	+150						
Cu							0.12	0.19	+58			
Mo							0.13	0.12	- 8			
Ni							0.07	0.10	+43			
Pb				0.07	0.12	+71						
Zn							0.43	0.41	-5			
As							0.02	0.01	-50			
Se							0.02	0.01	-50			

[a] Indeterminable because values were less than detection limit.

[b] The average value, in mg/kg, of results from seven depths.

[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a "-" sign) over the control.

TABLE 8 . STATISTICAL SUMMARY OF 100 CM LEACHATE

Constituent/ Form	Significance Level, Percent											
	96 - 99%			90 - 95%			Less than 90%			Indeterminable Results[a]		
	Mean Values[b] Control	Test	%[c] Diff.	Mean Values Control	Test	% Diff.	Mean Values Control	Test	% Diff.	Mean Value Control	Test	% Diff.
TC							27	29	+7			
FC							4	<2	-75			
TDS	2,505	1,920	-23									
B	0.65	1.02	+57									
Cl				288	227	-21						
F				0.9	0.7	-22						
NO_3-N				32.5	53.0	+63						
TN							34.1	47.5	39			
TOC							29.4	19.1	-35			
PO_4-P							3.0	2.9	-3			
SO_4	881	284	-68									
K	12.4	16.1	+30									
Na							284	267	-6			
Ca	195	74	-62									
Mg							135	121	-10			
Ba							0.22	0.23	+5			
Cd							0.02	0.02	0			
Cr				0.05	0.02	-60						
Cu							0.13	0.14	+8			
Mo				0.10	0.16	+60						
Ni							0.05	0.07	-40			
Pb				0.13	0.09	-31						
Zn	0.59	0.25	-58									
As							0.01	0.01	0			
Sc							0.01	0.01	0			

[a] Indeterminable because values were less than detection limit

[b] The average value, in mg/kg, of results from seven depths.

[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a "-" sign) over the control.

Table 9 compares the mean values of the water data (irrigation and leachate), between the test and control sites according to soil depth. Also included in the table for each constituent are the levels of confidence for the correlation coefficient developed between the test and control sites. The total dissolved solids increased from less than 1,000 mg/l at zero depth to over 1,900 mg/l at the 100-cm subsurface depth at both the test and control sites. A 99 percent confidence level indicates that there is a high correlation between the two sites. Similarly, nitrates (from 4.6 mg/l and less, to 32.5 mg/l and more), total nitrogen (from 15 mg/l and less, to over 34 mg/l), and sodium (from 212 mg/l or less, to over 265 mg/l) increased in concentration with depth, for both the test and control sites. Again, a 99 percent confidence level showed that the increase of these constituents occurred at both the test and control sites. Probable correlations (at 95 percent level of confidence) existed between the test and control sites' magnesium data. As shown, the magnesium concentration generally increased with depth. Since magnesium is a soluble cation, it would be expected that it would leach out with depth. The total organic carbon and the phosphate show probable negative correlation (95 percent confidence level) between the test and control sites. Both these control site constituents increased with depth from 3.8 mg/l TOC and 0.3 mg/l PO_4-P to 29.4 mg/l TOC, and 3.0 mg/l PO_4-P, respectively. In contrast, these test site sample constituents decreased from the top of the soil down to the 300-cm depth. As shown earlier, and in Table 6, the total organic carbon, a measure of the organic content, found in the test effluent was over eight times greater than the control site irrigation water. Thus, the decrease at the test site shows that the soil was effective in attenuating the organic material found in the test effluent. Although the data shown for the control site seem to contradict the above statement, as stated previously, the difference in total organic carbon between the test and control sites' leachate was insignificant. As will be explained later in this section, fertilizer in the form of phosphates and other nutrients was applied to both the test and control site. The additional organic matter at the control site may have been from vegetation which was plowed under. For phosphates, the values between the test and control site leachate samples were, again, not significantly different. The total quantity of phosphate applied as fertilizer was significantly greater than the quantity obtained from either the irrigation control water or the test effluent. Thus, in relation to the total quantity of phosphates added (by fertilizer and irrigation water), there was no apparent difference between the test and control sites.

The confidence levels for the heavy metals were not calculated because there were no distinct increases or decreases of concentration with depth. Therefore, with most of the heavy metal concentrations being low and near the detection limit of the analytical method, a valid correlation behind the two sites could not be calculated.

The total and fecal coliform showed no significant difference between the test and control sites (one high value for the test site was not included due to an error in sampling). In fact, the decrease of coliform at the test site indicated that the coliform count was greatly reduced with passage through the soil.

TABLE 9. COMPARISON OF MEAN VALUES OF IRRIGATION WATER AND LEACHATE ACCORDING TO DEPTH[a]

Depth	Total Colif.[b]		Fecal Colif.[b]		TDS		B		Cl		F		NO_3-N		TN	
(cm)	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test
0	<2	57,000	<2	220	733	995	0.23	0.85	73	166	0.6	1.6	2.1	4.6	3.5	15.0
50	4	40	<2	<2	1,996	1,741	0.74	0.89	217	247	1.1	0.8	28.2	34.6	27.5	36.6
100	85	180	4	<2	2,505	1,920	0.65	1.00	288	227	0.9	0.7	32.5	53.0	34.1	47.5
300	--	14	--	5	--	1,719	--	1.14	--	220	--	1.0	--	62.2	--	63.8
Level of Confidence - % (correlation coefficient)	<80		<80		<75		<80		<80		<80		80		90	

Depth	TOC		PO_4-P		SO_4		K		Na		Ca		Mg		Ba	
(cm)	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test
0	3.8	34.7	0.3	11.8	227	194	4.6	16.9	88	212	50	55	40	34	0.17	0.08
50	27.2	26.1	3.8	4.8	434	267	15.4	26.9	217	247	94	112	127	155	0.11	0.19
100	29.4	19.0	3.0	2.8	881	284	12.4	16.1	284	267	195	74	135	121	0.22	0.23
300	--	11.2	--	0.2	--	246	--	11.6	--	300	--	83	--	174	--	0.09
	-90		<80		80		<80		99		<80		<80		<80	

Depth	Cd		Cr		Cu		Mo		Ni		Pb		Zn		As[c]	
(cm)	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test
0	0.01	0.02	0.03	0.02	0.13	0.06	0.10	0.11	0.05	0.10	0.05	0.05	0.05	0.05	0.01	0.01
50	0.03	0.02	0.02	0.05	0.12	0.19	0.13	0.12	0.07	0.10	0.07	0.12	0.43	0.41	0.02	0.01
100	0.02	0.02	0.05	0.02	0.13	0.14	0.10	0.16	0.05	0.07	0.13	0.09	0.59	0.25	0.01	0.01
300	--	0.01	--	0.05	--	0.10	--	0.32	--	0.10	--	0.05	--	0.08	--	0.01

[a] Values reported as mg/l, unless otherwise noted. [c] All values for selenium are the same as arsenic values.

[b] Values reported as MPN/100 ml.

There appears to be little correlation between the test and control sites for boron, chloride, fluoride, sulfate, potassium, copper, and barium. Sulfate, however, increased with the depth at both sites but at a slower rate at the test site. There may not be a good correlation between the sites for potassium because of different amounts of fertilizer applied. The lack of correlation for the remaining constituents were due to the real significant differences between the test site effluent and the control site irrigation water, as noted previously.

Groundwater Analysis

The test wells were statistically evaluated to determine possible groundwater contamination by the effluent irrigation water. There were no control wells; however, because the on-site well (1) was near the entry of the test site, it could be considered a control-type well. Thus, the on-site well, considered to be the control, was compared with the lateral well (2) downstream and north of the test site, and the downstream well (3) west of the test site.

Table 10 and 11 present the statistical comparison between the upper and lower layers of the on-site and lateral test monitoring wells. The monitoring wells sampled the leachate at the upper layer of the groundwater rather than the entire groundwater stratum. The coliform count for the lateral well (2) sample was significantly higher than the on-site well (1). Fecal coliform was less than 2 (below the detection limit) at both groundwater sites. The downstream well (3) samples showed similar results.

Since the total dissolved solids content in the leachate continually increased through the soils, it would be expected that the dissolved solids would also increase downstream from the on-site groundwater. However, the difference in the total dissolved solids between the lateral and the on-site well samples was insignificant. This may be explained by noting that the sulfates, a probable dissolved salt, decreased about 32 percent while the chlorides significantly increased by 84 percent at the upper layer of the monitoring wells, and 78 percent at the lower layer of the well; thus, even though the total dissolved solids remained nearly the same, the salt content did increase significantly at the lateral groundwater site. Magnesium, another dissolved salt, was 118 percent higher at the upper layer of the lateral groundwater than in the on-site well water. Of the nutrients, the nitrates and total nitrogen passed through the soil into the groundwater, evidenced by a significant increase of about 27 percent at the top of the lateral well site as compared to the on-site groundwater. The lower layer of the lateral well samplings showed an even larger, 64 percent, increase in nitrate and total nitrogen content. The other nutrients, potassium and phosphates showed relatively insignificant differences between the on-site and lateral wells. Only potassium, at the top of the lateral well, was significantly lower than the on-site well water, and the phosphates showed probable significant increases (confidence level between 90 and 95 percent) at the lower level of the lateral well. Of the heavy metals, only copper, at the top of the wells, showed any significant increase (level of confidence of 96 to 99 percent) in the lateral groundwater, as compared to the on-site well location. The other heavy metals and the other inorganic

TABLE 10. STATISTICAL SUMMARY OF TEST WELL TOP SAMPLES – UPSTREAM(1)VS LATERAL(2)

	Significance Level, Percent											
Constituent/ Form	96 - 99%			90 - 95%			Less than 90%			Indeterminable Results[a]		
	Mean Values[b] Wells (1)	(2)	%[c] Diff.	Mean Values Wells (1)	(2)	% Diff.	Mean Values Wells (1)	(2)	% Diff.	Mean Value Wells (1)	(2)	% Diff.
TC							<2	22	1,100			
FC							<2	<2	0			
TDS							3,004	3,232	+8			
B							0.88	0.67	-24			
Cl	262	483	+84									
F							1.0	1.3	+30			
NO_3-N	39.9	50.9	+28									
TN	41.3	51.9	+26									
TOC							9.0	11.9	+32			
PO_4 -P							0.4	0.4				
SO_4	1,379	931	-32									
K	11.6	5.2	-55									
Na							288	258	-10			
Ca							178	204	+15			
Mg	76.6	167	+118									
Ba							0.13	0.12	-8			
Cd							0.02	0.02	0			
Cr				0.09	0.04	-56						
Cu	0.04	0.07	+75									
Mo	0.17	0.09	-47									
Ni							0.10	0.10	0			
Pb							0.09	0.10	+11			
Zn							0.05	0.06	720			
As							0.01	0.01	0			
Se							0.01	0.01	0			

[a] Indeterminable because values were less than detection limit.

[b] The average value, in mg/kg, of results from seven depths.

[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a "–" sign) over the control.

TABLE 11. STATISTICAL SUMMARY OF TEST WELL BOTTOM SAMPLES–UPSTREAM(1) VS. LATERAL (2)

Constituent/ Form	Significance Level, Percent 96 - 99% Mean Values[b] Wells (1)			90 - 95% Mean Values Wells (1)			Less than 90% Mean Values Wells (1)			Indeterminable Results[a] Mean Value Wells (1)		
	(1)	(2)	%[c] Diff.	(1)	(2)	% Diff.	(1)	(2)	% Diff.	(1)	(2)	% Diff.
TC							<2	45	2,250			
FC							<2	<2	0			
TDS							3,524	3,330	-6			
B				1.14	0.81	-29						
Cl	297	530	+78									
F							1.27	1.11	-13			
NO_3-N	38.2	62.6	+64									
TN	38.6	63.2	+64									
TOC							10.3	14.7	+43			
PO_4-P				0.28	0.66	+140						
SO_4	1,386	923	-33									
K							8.6	5.8	-33			
Na							299	257	-14			
Ca				166	199	+20						
Mg							243	176	-28			
Ba							0.13	0.12	-8			
Cd							0.03	0.02	-33			
Cr							0.10	0.04	-60			
Cu							0.05	0.06	+20			
Mo	0.19	0.11	-42									
Ni							0.10	0.11	+10			
Pb							0.09	0.12	+33			
Zn							0.07	0.05	-28			
As							0.01	0.01	0			
Se							0.01	0.01	0			

[a] Indeterminable because values were less than detection limit.

[b] The average value, in mg/kg, of results from seven depths.

[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a "–" sign) over the control.

constituents were not significantly different, or were lower in the lateral groundwater.

Tables 12 and 13 present the statistical comparison between the on-site groundwater and the downstream groundwater. Since the location of the downstream well (3) was below and across the test site, whereas the lateral well was located to the same side as the on-site well, the on-site/downstream comparisons may be more representative of the actual environmental impact. As shown in the tables, there were no significant differences in the heavy metal concentrations between the on-site and downstream groundwaters. This was expected since the effluent, for the most part, did not differ significantly from the control irrigation water. The results show that the fecal coliform count in the downstream and on-site groundwaters were below the analytical detection limits. The effluent fecal coliform were removed by the soil, thus, no fecal coliform reached the groundwater from the effluent. The total dissolved solids were another group of constituents which were significantly different in the irrigation waters. The impact of the dissolved solids' penetration to the groundwater is shown by the significantly greater content of total dissolved solids (by 30 and 14 percent) and chlorides (by 37 and 23 percent) in upper and lower levels of the downstream well locations, respectively. Magnesium, at the top of the downstream well, was also significantly higher by some 280 percent.

The nitrates and total nitrogen nutrients were higher in the downstream groundwater locations but did not increase as much as in the lateral well water. This shows that the nitrogen content of the leachate readily percolated through to the groundwater and was then diluted with the flow of the water downstream. The other nutrients, potassium and phosphorus, did not appear to leach through to the groundwater. In fact, the potassium content was significantly less in the downstream groundwater.

The other constituents (boron, fluorides, and total organic carbon), significantly different between the test and control irrigation waters, apparently increased during the percolation through the soils. The concentrations of these constituents became more similar with increasing depth, and were found to be insignificantly different between the on-site and downstream well locations.

Soil Analysis

The differences between the test site and control site soils will ultimately influence the characteristics of the leachate and the groundwaters. Two sets of soil samples at seven depths were collected - one before the water monitoring program was started and the other, near the end of the monitoring program (approximately one year later). The results of the initial soil samples are presented in Table 14. The results are listed by depth; the mean value and standard deviation are also given. In Table 15 the correlation coefficients are presented for four levels of correlation by constituent. The correlation coefficient was used to determine if there were any significantly similar trends between the test and control sites.

TABLE 12. STATISTICAL SUMMARY OF TEST WELL TOP SAMPLES–UPSTREAM(1) VS. DOWNSTREAM (3)

Constituent/ Form	Significance Level, Percent											
	96 - 99%			90 - 95%			Less than 90%			Indeterminable Results[a]		
	Mean Wells Values[b] (1)	Mean Wells Values[b] (3)	%[c] Diff.	Mean Wells Values (1)	Mean Wells Values (3)	% Diff.	Mean Wells Values (1)	Mean Wells Values (3)	% Diff.	Mean Wells Value (1)	Mean Wells Value (3)	% Diff.
TC	< 2	49	2,950									
FC							< 2	< 2	0			
TDS	3,004	3,916	+30									
B							0.88	0.99	+13			
Cl	262	358	+37									
F							1.02	1.23	+21			
NO_3-N	39.9	52.8	+32									
TN	41.3	53.9	+31									
TOC							9.0	13.0	+44			
PO_4-P							0.4	0.5	+25			
SO_4				1,379	1,644	+19						
K	11.6	4.65	-60									
Na				288	301	+5						
Ca							178	198	+11			
Mg	72.6	280	+ 286									
Ba							0.13	0.14	+8			
Cd							0.02	0.02	0			
Cr							0.09	0.07	-22			
Cu							0.04	0.06	+50			
No							0.17	0.22	+29			
Ni							0.10	0.10	0			
Pb							0.09	0.11	22			
Zn							0.05	0.05	0			
As							0.01	0.01	0			
Se							0.01	0.01	0			

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[a] Indeterminable because values were less than detection limit.

[b] The average value, in mg/kg, of results from seven depths.

[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a "-" sign) over the control.

TABLE 13. STATISTICAL SUMMARY OF TEST WELL BOTTOM SAMPLES- UPSTREAM(1) VS. DOWNSTREAM (3)

Constituent/ Form	Significance Level, Percent 96 - 99% Mean Values[b] Wells (1)	96 - 99% Mean Values[b] Wells (3)	96 - 99% %[a] Diff.	90 - 95% Mean Values Wells (1)	90 - 95% Mean Values Wells (3)	90 - 95% % Diff.	Less than 90% Mean Values Wells (1)	Less than 90% Mean Values Wells (3)	Less than 90% % Diff.	Indeterminable Results[a] Mean Value Wells (1)	Indeterminable Results[a] Mean Value Wells (3)	Indeterminable Results[a] % Diff.
TC				<2	410	20,000						
FC							<2	<2	0			
TDS	3,524	4,002	+14									
B							1.14	1.05	-8			
Cl	297	366	+23									
F							1.3	1.1	-15			
NO_3-N				38.2	44.3	+11						
TN				38.6	45.6	+18						
TOC							10.3	13.5	+31			
PO_4-P							0.28	0.60	+114			
SO_4							1,386	1,586	+14			
K				8.6	5.2	-40						
Na							299	294	-2			
Ca							166	190	+14			
Mg							243	295	+21			
Ba							0.13	0.16	+23			
Cd							0.03	0.02	-33			
Cr				0.10	0.03	-70						
Cu							0.05	0.07	+40			
Mo							0.19	0.23	+21			
Ni							0.10	0.10	0			
Pb							0.09	0.12	+33			
Zn							0.07	0.08	+14			
As							0.01	0.01	0			
Se							0.01	0.01	0			

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[a] Indeterminable because values were less than detection limit.

[b] The average value, in mg/kg, of results from seven depths.

[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a "-" sign) over the control.

TABLE 14 . INITIAL SOIL CHEMICAL ANALYSES (OCTOBER 1976)[a]

mg/kg unless noted Site	Depth (cm)	B	Cl	F	NO_3-N	N[b]	PO_4	P	P Organic	K		Na	Ca		
		WE[c]	WE	WE	WE	T[d]	WE	AE[e]	T	WE	EX[f]	WE	AE	WE	EX
Test	1	7.8	209	11	82	966	15	902	165	104	1,770	226	9,930	96	4,800
	3	6.3	150	20	28	732	16	582	150	112	1,780	217	11,160	104	3,720
	10	6.5	100	12	18	975	20	859	< 20	121	1,660	220	11,000	92	3,860
	30	6.4	250	14	37	925	22	638	< 20	122	1,500	216	8,400	78	3,800
	100	6.5	150	4	56	1,115	10.2	542	149	50	785	238	10,100	88	2,500
	200	5.2	150	10	79	1,100	4.2	632	145	39	600	230	13,300	63	2,200
	300	4.3	125	18	46	978	1.6	1,043	305	22	1,000	257	12,200	90	3,900
Mean		6.1	160	12.71	49.36	970	12.6	742	135	81	1,300	229	10,865	87	3,543
Std. Dev.		1.0	49	5.31	24.32	126	7.8	190	98	43	494	14	1,587	13	895
Control	1	5.2	175	7	150	840	27	640	316	129	1,670	234	6,020	52	2,390
	3	4.8	100	2	60	654	30	692	281	134	1,610	168	5,955	22	2,815
	10	4.1	250	4	8	493	16	635	235	132	1,490	243	6,470	54	2,620
	30	4.4	175	7	44	566	25	671	40	141	1,590	144	7,740	25	3,110
	100	4.0	175	4	25	570	8.6	416	245	48	1,210	158	8,180	96	2,600
	200	5.1	150	8	35	667	3.1	422	540	56	1,720	176	11,300	174	2,550
	300	5.1	125	4	30	444	4.0	312	371	49	1,220	197	11,700	165	2,600
Mean		4.6	164	5.14	50	604	16.1	541	289	98	1,458	188	8,193	83	2,667
Std. Dev.		0.5	47	2.19	46	130	11.1	153	152	44	186	37	2,408	63	231

(continued)

TABLE 14 . (continued)

Site	Depth	Mg				CEC[9]	Ag		Ba	Cd		Cr		Cu		Mn	
	(cm)	T	AE	WE	EX		T	AE	T	T	AE	T	AE	T	AE	T	AE
Test	1	8,050	2,820	62	550	21.9	<20	< 1.0	706	10	1.6	111	17	28	3.1	419	238
	3	5,700	2,240	68	389	17.1	<20	< 1.0	880	6	1.5	144	18	25	1.7	380	175
	10	10,360	2,780	60	479	15.7	<20	< 1.0	560	< 5	2.0	135	16	31	1.4	474	200
	30	5,840	2,890	62	530	13.8	<20	< 1.0	1,110	7	1.8	130	14	26	1.9	433	206
	100	6,490	2,060	58	594	12.6	<20	< 1.0	650	5	1.4	118	16	24	1.5	419	176
	200	5,575	2,160	54	882	9.2	<20	< 1.0	960	< 5	1.3	100	16	27	4.6	357	149
	300	9,800	2,900	81	765	9.9	<20	< 1.0	2,010	< 5	1.8	106	18	28	0.4	407	197
Mean		7,331	2,543	60	598	14	<20	< 1.0	1,015	5.0	1.6	120	16	27	2.09	417	165
Std. Dev.		2,094	371	4	170	3.7	--	--	477	2.8	0.2	16	1.6	2.31	1.36	37	18
Control	1	5,940	1,880	86	353	20.6	<20	< 1.0	435	< 5	1.5	142	12	49	3.0	413	166
	3	6,500	1,680	50	458	12.0	<20	< 1.0	380	< 5	1.9	149	14	30	2.5	544	161
	10	5,570	1,980	93	490	10.1	<20	< 1.0	623	< 5	1.8	148	12	32	2.0	515	138
	30	4,700	1,860	30	599	7.7	<20	< 1.0	413	< 5	1.6	149	6	26	1.2	335	156
	100	8,735	2,020	32	596	8.8	<20	< 1.0	392	< 5	1.5	131	13	47	1.5	412	159
	200	3,600	1,720	53	728	10.8	<20	< 1.0	807	< 5	1.2	131	5	23	1.8	336	177
	300	10,600	1,460	34	314	15.1	<20	< 1.0	840	< 5	1.25	163	10	29	0.2	410	198
Mean		6,617	1,802	54	502	12.1	<20	< 1.0	562	< 5	1.5	144	10.1	33	1.7	423	165
Std.Dev.		2,395	196	25	150	4.4	--	--	204	--	0.26	11	3.6	10.1	0.9	80	18

(continued)

TABLE 14 . (continued)

Site	Depth (cm)	Mo	Ni		Pb		Zn		As		Hg		Se	
		T	T	AE	T	AE	T[h]	AE	T	AE	T	AE	T	AE
Test	1	<20	91	17	63	3.8	--	8.1	3.7	0.5	<1.0	<0.09	<2.0	<0.10
	3	<20	81	17	67	4.2	--	7.6	5.2	0.5	2.0	<0.05	<2.0	<0.10
	10	<20	93	16	51	4.0	--	8.6	3.0	0.6	<1.0	<0.05	<2.0	<0.10
	30	<20	86	20	57	6.6	--	8.3	2.9	1.4	<1.0	<0.05	<2.0	<0.10
	100	<20	96	19	47	4.6	--	5.0	2.2	0.3	<1.0	<0.05	<2.0	<0.10
	200	<20	71	16	50	3.8	< 5.0	6.1	3.4	0.4	<1.0	<0.05	<2.0	<0.10
	300	<20	75	16	44	3.6	--	8.0	2.6	0.4	<1.0	<0.05	<2.0	<0.10
Mean		<20	84.71	17.33	54.14	4.41	a	7.40	3.30	0.59	<1.0	<0.05	<2.0	<0.10
Std. Dev.		--	9.43	1.60	8.49	1.04	a	1.34	0.99	0.37	--	--	--	--
Control	1	30	54	11	122	64	--	8.4	8.4	1.7	<1.0	<0.05	<2.0	<0.10
	3	30	74	14	115	59	--	9.4	9.4	1.7	<1.0	<0.05	<2.0	<0.10
	10	20	78	12	126	55	--	7.1	7.1	1.7	<1.0	<0.08	<2.0	<0.10
	30	30	54	10	46	5.0	--	7.2	7.2	1.0	<1.0	<0.05	<2.0	<0.10
	100	20	70	12	55	4.4	--	7.9	7.9	0.5	<1.0	<0.05	<2.0	<0.10
	200	30	50	13	41	3.6	5.0	4.4	4.4	0.3	<1.0	<0.05	<2.0	<0.10
	300	30	66	8	54	3.0	5.0	4.8	4.8	0.4	<1.0	<0.05	<2.0	<0.10
Mean		27.14	63.71	11.48	121.00[i] 49.00[k]	59.5[i] 3.98[k]	a	7.02	7.03	1.53[j] 0.40[l]	<1.0	<0.05	<2.0	<0.10
Std. Dev.		4.88	11.04	2.17	5.57[i] 6.68[k]	4.77[i] 0.91[k]	a	1.83	1.83	0.35[j] 0.10[l]	--	--	--	--

[a] Averages of two composited samples.

[b] Total nitrogen = nitrates plus kjeldahl nitrogen.

[c] WE = water extractible

[d] T = total digestible

[e] AE=acid extractible

[f] EX=exchangeable

[g] CEC = cation exchange capacity, meq/100 gm

[h] Bad samples

[i] 1- to 10-cm depth

[j] 1- to 30-cm depth

[k] 30- to 300-cm depth

[l] 100- to 300-cm depth

The soil analyses were compared by statistically evaluating the difference in means between the test and control sites by using the H-test. The statistical summary of the initial soil samples is presented in Table 15. The test site was significantly greater (level of confidence between 96 and 99 percent) than the control site in the following constituents: by 30 percent for water-extracted boron; by 480 percent for water-extracted fluoride; by 60 percent for total nitrogen; by 33 percent for acid-extracted sodium and exchangeable calcium; by 41 percent for acid-extracted magnesium; by 80 percent for total barium; by 70 percent for acid-extracted chromium; by 35 percent for total molybdenum; and by 33 and 55 percent for total and acid-extracted nickel, respectively.

Those constituents which were lower in content at the test site were organic phosphorus, water-extracted sodium, total chromium, total and acid-extracted lead between 1-and 10-cm depth, and total and acid-extracted arsenic between 1-and 30-cm depth. The nearly 150 percent increase in lead content in the first 10 cm of the control soil was likely due to the proximity of the freeway and the subsequent vehicular fallout from air pollution. Total copper content with a level of confidence between 90 and 95 percent, was considered significantly lower at the test site. The differences between the test and control sites for the other constituents [water-extracted chloride, nitrates, phosphate, potassium, calcium, and magnesium; exchangeable potassium, calcium and magnesium; cation exchange capacity; total silver, cadmium, magnanese, lead (from 30- to 300-cm depth), mercury, and selenium;] and acid-extracted silver, cadmium, copper, manganese, lead (from 30- to 300-cm depths), arsenic (from 100- to 300-cm depths) mercury, and selenium did not differ significantly between the test and control soils. Most of these constituents which showed significant differences between the two sites are either water- or acid-extracted samples; therefore, although the actual total content is generally the same, the difference in the extracted constituents was possibly due to different physical characteristics of the soils (see Table 5), such as hydraulic capacity, etc. Other differences might possibly be due to the land uses and fertilizer application prior to the study.

Near the end of the water monitoring program, a final set of soil samples at seven depths were collected and chemically analyzed. The results of these analyses are presented in Table 16. For most of the constituents, the contents of the test site did not statistically correlate with the control site. The primary reason for a low degree of correlation was probably due to the contents changing insignificantly through the depths of the soil; therefore, a comparison of a decreasing or increasing trend could not be obtained. Total nitrogen and acid-extracted copper decreased in content with depth about 65 percent for total nitrogen from 3-cm to 300-cm depth, and 65 percent for the test site extracted copper and 48 percent for the control site copper. Water-extracted chloride water- and acid-extracted phosphates, exchangeable potassium, and total digested magnesium and chromium contents generally decreased with depth.

TABLE 15. STATISTICAL SUMMARY OF INITIAL CONTROL AND TEST SITES, SOIL CHEMICAL ANALYSES

Constituent/ Form		Significance Level, Percent 96 - 99%[b] Mean Control	Values Test	%[c] Diff.	90 - 95% Mean Control	Values Test	% Diff.	Less than 90% Mean Control	Values Test	% Diff.	Indeterminable Results[a] Mean Control	Value Test	% Diff.
B	WE[d]	4.7	6.1	+30									
Cl	WE							164	161	-2			
F	WE	2.2	12.7	+480									
NO_3-N	WE							50	49	-2			
N	T[e]	605	970	+60									
PO_4P	WE							16	13	-19			
P	AE[f]	541	743	+37									
P org.	T	289	136	-53									
K	WE							98	82	+20			
	EX[g]							1,460	1,300	-11			
Na	WE	189	229	-17									
	AE	8,200	10,900	+33									
Ca	WE							84	87	+4			
	EX	2,670	3,540	+33									
Mg	T							6,620	7,330	+11			
	AE	1,800	2,540	+41									
	WE							54	61	+13			
	EX							500	600	+ 12			
CEC								12.2	14.3	+17			
Ag	T										< 20	< 20	
	AE										<1.0	<1.0	
Ba	T	563	1,015	+80									
Cd	T										< 5	5	+1
	AE										1.5	1.6	+2
Cr	T	145	120	-17									
	AE	10	17	+70									

(continued)

TABLE 15 (continued)

Constituent/ Form		Significance Level, Percent 96 - 99%[b] Mean Control	Values Test	%[c] Diff.	90 - 95% Mean Control	Values Test	% Diff.	Less than 90% Mean Control	Values Test	% Diff.	Indeterminable Results[a] Mean Control	Value Test	% Diff.
Cu	T				34	27	-21						
	AE							1.7	2.1	+24			
Mn	T							424	413	-3			
	AE							165	165	0			
Mo	T	<20	27	≥+35									
Ni	T	64	85	+33									
	AE	11	17	+55									
Pb	T												
	(1-10 cm)	121	54	-55									
	(30-300 cm)							49	54	+10			
	AE												
	(1-10 cm)	60	4.4	-93									
	(30-300 cm)							4.0	4.4	+10			
Zn	T												
	AE												
As	T	7.0	3.3	-53									
	AE												
	(1-30 cm)	1.5	0.6	-60									
	(100-300 cm)							0.4	0.6	+50			
Hg	T										< 1.0	< 1.0	
	AE										< 0.05	0.05	
Se	T										< 2.0	< 2.0	
	AE										< 0.1	< 0.1	

[a] Indeterminable because values were less than detection limit.

[b] The average value, in mg/kg, of results from seven depths or as noted.

[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a "-" sign) over the control.

[e] T=total digestible.

[f] AE= acid extractible.

[g] EX= exchangeable.

[h] Value reported as meq/100gm.

TABLE 16. FINAL SOIL CHEMICAL ANALYSIS (SEPTEMBER 1977)[a]

mg/kg unless noted Site	Depth (cm)	B	Cl	F	NO_3-N	N[b]	PO_4	P	P Organic	K		Na		Ca	
		WE[c]	WE	WE	WE	T[d]	WE	AE[e]	T	WE	EX[f]	WE	AE	WE	EX
Test	1	2.3	270	6	65	705	12	399	115	101	1,600	285	9,850	43	3,490
	3	2.1	290	5	68	902	22	419	75	148	1,760	275	10,300	77	3,450
	10	2.0	228	6	63	796	15	424	210	120	1,670	255	10,100	63	3,630
	30	1.6	155	5	69	531	13	323	115	34	1,160	215	9,590	17	3,610
	100	2.1	165	8	47	536	7.3	352	70	22	815	320	8,410	16	3,580
	200	2.0	124	8	13	261	< 1.0	225	50	9	848	315	12,500	13	4,170
	300	1.3	166	7	20	319	< 1.0	240	< 20	11	920	300	8,590	14	3,710
Mean		1.9	199	6.4	49	578	10	340	92	63	128	280	9,905	34	3,662
Std. Dev.		0.3	63	1.2	23	238	7.8	82	63	57	413	39	1,353	26	239
Control	1	1.5	249	6	58	577	14	300	85	93	2,020	240	3,030	22	3,200
	3	1.7	186	11	37	737	21	323	289	78	1,630	185	2,800	13	3,140
	10	1.9	113	26	47	741	29	240	120	115	1,300	165	2,850	5	3,120
	30	2.1	135	23	--	--	31	251	<20	117	1,110	185	2,910	4	3,000
	100	1.7	124	27	57	317	22	222	75	14	745	210	5,270	58	3,860
	200	1.9	113	27	36	169	6.3	147	275	23	850	205	11,300	173	3,580
	300	0.8	124	19	63	266	< 1.0	258	100	29	796	205	12,100	99	3,590
Mean		1.6	149.14	19	49	462	17	248	136	67	1,208	199	5,751	53	3,355
Std. Dev.		0.4	50.67	8.3	11	249	11	56	1.05	44	478	23	4,162	62	3,947

(continued)

TABLE 16 (continued)

Site	Depth (cm)	Mg				CEC^g	Ag		Ba	Cd		Cr		Cu		Mn	
		T	AE	WE	EX		T	AE	T	T	AE	T	AE	T	AE	T	AE
Test	1	17,000	1,360	77	664	29.5	<20	<1.0	595	6	1.8	165	4.1	42	6.3	538	190
	3	10,300	2,160	85	654	26.9	<20	<1.0	331	<5	1.9	166	4.7	31	6.3	548	196
	10	12,300	1,730	69	666	29.3	<20	<1.0	369	<5	1.9	131	4.5	27	6.2	505	193
	30	19,500	1,970	28	653	23.8	<20	<1.0	691	<5	1.7	123	3.7	23	5.3	525	143
	100	21,700	1,840	21	1,090	36.7	<20	<1.0	397	<5	2.2	158	3.3	29	3.7	535	135
	200	26,700	1,870	15	1,050	28.7	<20	<1.0	704	<5	1.9	155	2.6	33	1.7	560	129
	300	21,400	1,940	22	1,340	29.0	<20	<1.0	563	<5	1.5	235	4.4	35	2.2	519	131
Mean		18,414	1,838	45	873	29	<20	<1.0	521	<5	1.8	161	3.9	31	4.5	532	159
Std. Dev.		5,697	249	30	282	3.9	--	--	155	--	0.2	36	0.7	6.1	1.9	18	31
Control	1	11,800	1,310	47	1,020	25.5	<20	<0.1	831	<5	1.9	139	3.5	45	7.7	473	168
	3	11,700	1,330	17	938	30.5	<20	<0.1	781	<5	1.5	196	3.3	45	6.7	487	152
	10	10,300	1,170	9.5	905	24.5	<20	<0.1	826	<5	1.5	137	3.6	47	6.8	470	132
	30	10,900	1,340	12	882	21.3	<20	<0.1	822	<5	1.4	143	2.9	40	5.9	461	98
	100	12,800	1,240	37	993	19.5	<20	<0.1	821	<5	1.1	189	5.2	36	5.2	499	95
	200	15,600	1,180	55	506	23.5	<20	<0.1	863	<5	1.3	137	4.1	29	4.0	506	115
	300	18,100	1,360	37	699	23.5	<20	<0.1	767	<5	1.6	226	3.7	34	4.0	501	106
Mean		13,028	1,275	21	849	24	<20	<1.0	816	<5	1.5	167	3.8	39	5.8	485	124
Std. Dev.		2,818	78	18	184	3.5	--	--	32	--	0.25	36	0.7	6.7	1.4	18	28

(continued)

TABLE 16 (continued)

Site	Depth (cm)	Mo	Ni		Pb		Zn		As		Hg		Se	
		T	T	AE	T	AE	T	AE	T	AE	T	AE	T	AE
Test	1	<20	81	7.9	40	6.5	114	20	<2.0	<0.1	<0.5	<0.05	12	<0.1
	3	<20	81	8.3	31	6.5	92	22	<2.0	<0.1	<0.5	<0.05	7.4	<0.1
	10	<20	76	8.1	36	7.2	99	22	<2.2	<0.1	<0.5	<0.05	16	<0.1
	30	<20	77	9.0	45	5.7	98	22	<2.0	<0.1	<0.5	<0.05	8.9	<0.1
	100	<20	87	7.6	22	4.8	138	10	<2.0	<0.1	<0.5	<0.05	24	<0.1
	200	<20	71	7.2	25	4.4	87	7.3	<2.0	<0.1	<0.5	<0.05	25	<0.1
	300	<20	64	7.5	37	3.5	91	8.2	<2.0	<0.1	<0.5	<0.05	14	<0.1
Mean		<20	77	7.9	33.7	5.5	102	15.9	<2.0	<0.1	<0.5	<0.05	15	<0.1
Std. Dev.		--	7	0.6	8.20	1.3	18	7.0	--	--	--	--	7	--
Control	1	<20	71	9.5	162	43.4	98	20	<2.0	<0.1	<0.5	<0.05	27	<0.1
	3	<20	78	10.1	180	42.5	110	8.9	10.1	<0.1	<0.5	<0.05	24	<0.1
	10	<20	80	9.9	156	35.5	70	11	9.4	<0.1	<0.5	<0.05	22	<0.1
	30	<20	68	9.8	64	9.4	87	9.5	7.0	<0.1	<0.5	<0.05	17	<0.1
	100	<20	66	8.3	52	5.8	105	9.7	5.1	<0.1	<0.5	<0.05	21	<0.1
	200	<20	65	5.7	24	5.1	98	8.9	2.5	<0.1	<0.5	<0.05	29	<0.1
	300	<20	73	6.3	30	5.0	89	7.1	4.8	<0.1	<0.5	<0.05	17	<0.1
Mean		<20	72	8.5	166[h] 42[i]	40.4[h] 6.3[i]	93	10.7	5.7	<0.1	<0.5	<0.05	22	<0.1
Std. Dev.		--	6	1.8	12.5[h] 18.2[i]	4.3[h] 2.1[i]	13	4.2	3.4	--	--	--	5	--

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[a] Averages of two sub-compacted samples.
[b] Total nitrogen = nitrates plus kjeldahl nitrogen.
[c] WE = water exchangeable.
[d] T = total digestible
[e] AE = acid exchangeable
[f] EX = exchangeable
[g] Reported as meq/100 gm
[h] 1 - to 10 -cm depth.
[i] 30 - to 300 -cm depth

Table 17 presents the statistical summary comparing the test and control sites for the final soil samples. The constituents which were significantly greater in content at a 96 to 99 percent confidence level at the test site were acid-extracted phosphorus, by 37 percent; water and acid extracted sodium, by 41 and 72 percent, respectively; total magnesium, by 42 percent; cation exchange capacity, by 21 percent; cadmium, by 20 percent; and total and acid-extracted manganese, by 10 and 29 percent, respectively. The following constituents showed some significant differences (between 90 and 95 percent level of confidence), for chlorides, by 34 percent; exchangeable calcium by 9 per cent; and acid-extracted magnesium, by 44 percent. The following constituent concentrations were less in the test site soils than in the control site soils; fluorides, by 68 percent; total barium, by 36 percent; total copper by 21 percent; total and acid-extracted lead from 1 to 10 cm, by 80 and 86 percent, respectively; total arsenic, by 65 percent; and total selenium, by 32 percent.

In comparing the results of the final soil analysis with those of the first set, the acid-extracted potassium and total copper were greater at the test site by the same percentage; and extracted sodium, and magnesium were again higher at the test site, whereas, total and acid-extracted lead down to a 10-cm depth, and total arsenic were lower at the test site. Once more, the substantially greater lead content within the first 10 cm of the control site was due to the air pollution fallout caused by the automobiles traveling the nearby freeway.

The water-extracted chlorides, fluorides, sodium, and barium show reversed trends between the test and control sites. That is, the chloride and sodium contents were greater at the test site at the time of the final sampling, while these constituents were lower in the initial test site samples. This was understandable since the test effluent caused a buildup of salt content at the test site. Barium and fluorides were lower in the final test soil samples than in the initial test soil samples. The reversal of the barium content may have been due to the greater uptake of the constituent in the test-grown tomato plants (discussed later in this section).

Additional statistical comparison between initial and final soil analyses for the control site is presented in Table 18. The constituents which showed statistically significant (96 to 99 percent confidence level) increases between the initial and final soil samplings were: fluoride by 290 percent; exchangeable calcium by 26 percent; total and exchangeable magnesium by 96 and 69 percent, respectively; cation exchange capacity by 96 percent; total barium by 45 percent; acid-extracted copper by 240 percent; total lead in the first 10 cm by 37 percent; acid-extracted lead between 30 and 300 cm by 58 percent; acid-extracted zinc by 53 percent; and selenium by 1,000 percent. Total manganese and total nickel, by 13 to 14 percent, also saw probable signficant (90 to 95 percent) increases. These data show that there was no significant change in the constituents (water-extracted chloride, sodium, magnesium, and calcium) comprising the dissolved solids; consequently, the buildup of total dissolved solids in the leachate (733 to 2,505 mg/l from zero to 100-cm depth) was due only to the irrigation water rather

TABLE 17. STATISTICAL SUMMARY OF THE FINAL CONTROL AND TEST SITES, SOIL CHEMICAL ANALYSES

Constituent/	Form	Significance Level, Percent									Indeterminable Results[a]		
		96 - 99%[b]			90 - 95%			Less than 90%					
		Mean Values Control	Test	%[c] Diff.	Mean Values Control	Test	% Diff.	Mean Values Control	Test	% Diff.	Mean Value Control	Test	% Diff.
B	WE[d]							1.7	1.9	+12			
Cl	WE				149	200	+34						
F	WE	19.9	6.4	-68									
NO_3-N	WE							49.7	49.3	-1			
N	T[e]							468	579	+24			
PO_4-P	WE							11.4	10.0	-12			
P	AE[f]	249	340	+37									
P org.	T							136	92	-32			
K	WE							67	64	-4			
	EX[g]							1,210	1,250	+3			
Na	WE	199	281	+41									
	AE	5,750	9,900	+72									
Ca	WE							53	35	-34			
	EX				3,350	3,660	+9						
Mg	T	13,000	18,400	+42									
	AE				1,280	1,840	+44						
	WE							30.6	45.3	+48			
	EX							849	874	+3			
CEC[h]		24.0	29.1	+21									
Ag	T										< 20	< 20	
	AE										<1.0	<1.0	
Ba	T	816	521	-36									
Cd	T										< 5	< 5	
	AE	1.5	1.8	+20									
Cr	T							167	162	-3			
	AE							3.8	3.9	+3			

(continued)

TABLE17(continued)

Constituent/ Form		Significance Level, Percent 96 - 99%[b] Mean Control	Values Test	%[c] Diff.	90 - 95% Mean Control	Values Test	% Diff.	Less than 90% Mean Control	Values Test	% Diff.	Indeterminable Results[a] Mean Control	Value Test	% Diff.
Cu	T	39	31	-21									
	AE							5.8	4.5	-22			
Mn	T	485	533	+10									
	AE	124	160	+29									
Mo	T										< 20	< 20	
Ni	T							72	77	+7			
	AE							8.5	7.9	-7			
Pb	T												
	(1-10 cm)	166	34	-80									
	(30-300 cm)							42	34	-19			
	AE												
	(1-10 cm)	40.5	5.5	-86									
	(30-300 cm)							6.3	5.5	-13			
Zn	T							94	103	+10			
	AE							10.7	15.9	+49			
As	T	5.7	<2.0	≥-65									
	AE										< 0.1	< 0.1	
Hg	T										< 0.5	< 0.5	
	AE										< 0.05	< 0.05	
Se	T	22	15	-32									
	AE										< 0.1	< 0.1	

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[a] Indeterminable because values were less than detection limit.

[b] The average value, in mg/kg, of results from seven depths.

[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a "-" sign) over the control.

[d] WE= water extractible.

[e] T = total digestible.

[f] AE = acid extractible.

[g] EX = exchangeable.

[h] Value reported as meq/100 gm.

TABLE 18. STATISTICAL SUMMARY OF CONTROL SITE INITIAL AND FINAL SOIL CHEMICAL ANALYSES

Constituent/	Form	Significance Level, Percent 96 - 99%[b] Mean Values Initial	 Final	 % Diff.	90 - 95% Mean Values Initial	 Final	 % Diff.	Less than 90% Mean Values Initial	 Final	 % Diff.	Indeterminable Results[a] Mean Value Initial	 Final	 % Diff.
B	WE[d]	4.7	1.7	-64				164	149	-9			
Cl													
F	WE	5.1	19.9	+290				50	50	0			
NO_3-N	WE							604	468	-23			
N	T[e]							16	18	+13			
PO_4-P	WE												
P	AE[f]	541	249	-54									
P org.	T	289	136	-53				98	67	-32			
K	WE							1,460	1,210	-17			
	EX[g]							189	199	+5			
Na	WE							8,200	5,750	-30			
	AE							84	53	-37			
Ca	WE												
	EX	2,670	3,360	+26									
Mg	T	6,620	13,360	+96	1,800	1,280	-29						
	AE				54	31	-43						
	WE												
	EX	502	849	+69									
CEC[h]		12.2	24.0	+97							<20	< 20	
	T										<1.0	< 1.0	
	AE												
Ba	T	563	816	+45							<5	< 5	
Cd	T							1.5	1.5	0			
	AE							145	167	+15			
Cr	T												
	AE	10.2	3.8	-63									

(continued)

TABLE 18 (continued)

Constituent/ Form		Significance Level, Percent 96 - 99%[b] Mean Initial	Values Final	%[c] Diff.	90 - 95% Mean Initial	Values Final	% Diff.	Less than 90% Mean Initial	Values Final	% Diff.	Indeterminable Results[a] Mean Initial	Value Final	% Diff.
Cu	T							34	39	+15			
	AE	1.7	5.8	+240									
Mn	T				424	485	+14						
	AE	165	124	-25									
Mo	T	27	<20	- ≥26									
Ni	T				64	72	+13						
	AE	11	8.5	-23									
Pb	T												
(1-10 cm)		121	166	+37									
(30-300 cm)								49	42	-14			
	AE												
(1-10 cm)		60	40	-33									
(30-300 cm)		4.0	6.3	+58									
Zn	T	*											
	AE	7.0	10.7	+53									
As	T							7.0	5.7	-19			
	AE	1.0	<0.1	- ≥90									
Hg	T										< 1.0	< 0.5	
	AE										<0.05	< 0.05	
Se	T	<2.0	22	+ 1,000									
	AE										<0.10	< 0.10	

[a] Indeterminable because values were less than detection limit.
[b] The average value, in mg/kg, of results from seven depths.
[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a "-" sign) over the control.
[d] WE = water extractible.
[e] T = total digestible.
[f] AE = acid extractible.
[g] EX = exchangeable.
[h] Value reported as meq/100 gm.

than extraction from the soil. Another consideration was the increase in the cation exchange capacity, and the corresponding increase in the exchangeable calcium and magnesium during the period of the water monitoring program. This indicated that compaction and more clay-like characteristics of the soil developed during the monitoring period. There is no readily explainable reason for the buildup of fluorides. The increase in magnesium was probably due to the inclusion of the exchangeable magnesium into the soil matrix. The lead increase was most likely due to the continual pollution from the automobiles. There was a general buildup of barium,cooper,nickel,zinc,and selenium.

Table 19 summarizes the statistical comparison of the test soil between the initial and final samplings. As shown,the exchangeable magnesium and the cation exchange capacity significantly increased between the initial and final soil analyses. Similar to the control site, the test site soil appeared to have been compacted and changed to more clay-like characteristics. Water soluble sodium also significantly increased, confirming the results of the increased compaction. The acid-extracted and total copper, acid-extracted zinc, and total selenium showed significant increased content in test site soil as did the control soils. The soil content of the water-extracted boron, fluoride, calcium, total nitrogen,acid-extracted magnesium, phosphorus, chromium, manganese, nickel,total and acid-extracted arsenic, and total barium and nickel were all lower in the final sample.

The results of the initial biological soil analyses are presented in Table 20, which show that both the control site and test site soils effectively reduced the population of the protozoa,nematodes, and total coliform with depth. Although the protozoa population was still 100 per 10 grams at the 300-cm depth, the total population had been reduced by 100-fold. The nematodes and total coliform counts were reduced to below the detection limit at the 300-cm depth. There were no reported fecal coliform counts at any depth. The confidence level for the correlation between the control and test sites show that both soils very similarly and effectively attenuated the biological population with depth.

The final results of the biological analyses are presented in Table 21. In contrast to the initial sampling, the final set of soils showed that only the reduction of the protozoa populations of the test soils correlated significantly with the control soils. With depth, the protozoa population was reduced from more than 10^3/10 g to less than 20/10 g. Another significant difference relating to the protozoa population is that both sites in the final sampling were reduced to below the detection limit, whereas the initial samples showed reduction to only 100/10 g at both sites. The nematodes, total coliform, and fecal coliform counts in the final test soil did not correlate with the final control site. There were higher counts of nematodes in the control soil, particularly between 30-and 100-cm depths. Although the control soil did not show detectable total and fecal coliform counts at 200-cm depths and below, the test site soils contained more

TABLE 19. STATISTICAL SUMMARY OF TEST SITE INITIAL AND FINAL SOIL CHEMICAL ANALYSES

Constituent/	Form	Significance Level, Percent											
		96 - 99%			90 - 95%			Less than 90%			Indeterminable Results[a]		
		Mean Values[b] Initial	Final	%[c] Diff.	Mean Values Initial	Final	% Diff.	Mean Values Initial	Final	% Diff.	Mean Value Initial	Final	% Diff.
B	WE[d]	6.2	1.9	-69									
Cl	WE							161	200	+24			
F	WE	12.7	6.4	-50									
NO_3-N	WE							49	49	0			
N	T[e]	970	579	-40									
PO_4-P	WE							13	10	-23			
P	AE[f]	743	340	-54									
P org.	T							136	92	-32			
K	WE							82	64	-22			
	EX[g]							1,300	1,250	-4			
Na	WE	229	281	+23									
	AE							10,900	9,900	-9			
Ca	WE	87	35	-60									
	EX							3,540	3,670	+4			
Mg	T	7,330	18,400	+150									
	AE	2,540	1,840	-28									
	WE							61	45	-26			
	EX	599	874	+46									
CEC[h]		14.3	29.0	+103									
Ag	T										< 20	< 20	
	AE										< 1.0	<1.0	
Ba	T	1,015	521	-49									
Cd	T							5.1	<5	≥-2	5.1	5	≥-2
	AE				1.6	1.8	+13						
Cr	T	120	162	+35									
	AE	17	3.9	-77									

(continued)

TABLE 19 (continued)

Constituent/ Form		Significance Level; Percent											
		96 - 99%			90 - 95%			Less than 90%			Indeterminable Results[a]		
		Mean Values[b] Initial	Final	%[c] Diff.	Mean Values Initial	Final	% Diff.	Mean Values Initial	Final	% Diff.	Mean Value Initial	Final	% Diff.
Cu	T				27	31	+15						
	AE	2.1	4.5	+114									
Mn	T	413	533	+29									
	AE							165	160	-3			
Mo	T										< 20	< 20	
Ni	T	85	77	-9									
	AE	17	8	-53									
Pb	T	54	34	-37									
	AE				4.4	5.5	+25						
Zn	T												
	AE	7.4	16	+116									
As	T	3.3	2.0	≥-39									
	AE	0.6	<0.1	≥-83									
Hg	T										< 1.0	< 0.5	
	AE										< 0.05	< 0.05	
Se	T	<2.0	15	≥+650									
	AE										< 0.1	< 0.1	

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[a] Indeterminable because values were less than detection limit.

[b] The average value, in mg/kg, of results from seven depths.

[c] The percent the test result increased (designated by a "+" sign) or decreased (designated by a "-" sign) over the control.

[d] WE= water extractible.

[e] T = total digestible.

[f] AE = acid extractible.

[g] EX = exchangeable.

[h] Value reported as meq/100 gm.

TABLE 20. INITIAL SOIL BIOLOGICAL ORGANISM ANALYSES (OCTOBER 1976)

Site	Depth (cm)	Protozoa (Pop/10 gm)[a]	Nematodes (Population/10 gms)[a]	Total Coliform (MPN/gm)	Fecal Coliform (MPN/gm)[a]
Control					
	1	1×10^4	25	7.0×10^4	< 20
	3	1×10^4	55	2.9×10^5	< 20
	10	1×10^2	45	1.2×10^5	< 20
	30	1×10^2	60	4.0×10^3	< 20
	100	20	45	7.0×10^2	< 20
	200	1×10^2	0	2.0×10^2	< 20
	300	1×10^2	0	< 20	< 20
Mean		2.9×10^3	32	6.9×10^4	< 20
Std. Dev.		4.8×10^3	25	1.1×10^5	0
Test					
	1	1×10^4	30	1.1×10^5	< 20
	3	1×10^4	100	4.1×10^5	< 20
	10	1×10^3	75	2.8×10^5	< 20
	30	1×10^3	110	3.0×10^4	< 20
	100	1×10^3	65	2.0×10^2	< 20
	200	1×10^2	0	< 20	< 20
	300	1×10^2	0	< 20	< 20
Mean		3.3×10^3	54	1.2×10^5	< 20
Std. Dev.		4.6×10^3	45	1.6×10^5	0
Level of Confidence (correlation co-efficient (between control and test - %)		99.9	99.9	99.9	--

[a] Dry weight soil.

TABLE 21 . FINAL SOIL BIOLOGICAL ORGANISM ANALYSIS (SEPTEMBER 1977)

Site	Depth (cm)	Protozoa (Pop/10 gm)[a]	Nematodes (Population/10 gms)[a]	Total Coliform (MPN/gm)[a]	Fecal Coliform (MPN/gm)[a]
Control	1	3.5×10^3	9	$> 1.8 \times 10^5$	5.7×10^4
	3	3.4×10^3	0	2.0×10^4	<20
	10	7.8×10^3	0	2.1×10^4	<20
	30	1.2×10^3	70	1.2×10^4	<20
	100	< 20	10	1.9×10^2	3.6×10^1
	200	< 20	0	< 20	<20
	300	< 20	0	< 20	<20
Mean		2.3×10^3	13	3.6×10^4	8.2×10^3
Std. Dev.		2.9×10^3	26	6.4×10^4	2.2×10^4
Test	1	7.8×10^3	10	8.0×10^4	1.1×10^2
	3	8.2×10^3	0	4.0×10^4	1.6×10^3
	10	1.3×10^4	10	2.3×10^5	1.3×10^3
	30	1.5×10^3	0	4.1×10^4	5.5×10^1
	100	9.5×10^2	0	1.1×10^4	<20
	200	< 20	0	9.9×10^3	8.7×10^1
	300	< 20	0	5.9×10^3	<20
Mean		4.5×10^3	3	6.0×10^4	4.6×10^2
Std. Dev.		5.1×10^3	5	7.9×10^4	6.9×10^2
Level of Confidence (Correlation Coefficient between Control and Test -%)		99.9	< 80	< 80	<80

[a] Dry weight soil.

than 5 x 10^3 MPN/g of total coliform between 200 and 300 cm, and the fecal coliform count was 87 at the 200-cm depth. Even though the trend of reduced populations with depth were not similar between the test and control sites during the final samplings, the mean averages of the biological organisms' populations for all depths were not significantly different between the test and control sites, and between the initial and final soils, as shown in Table 22. The only significant exception being nematodes, less by 94 percent, in the final test soils when compared with the initial test soils. Consequently, the soils were generally effective in reducing the biological organisms. There were no major differences between the test and control sites in the land treatment of biological organisms.

WATER QUALITY COMPARISON

The analytical results of the irrigation water, leachate, and groundwater sampled at the test and control sites were compared to the EPA interim drinking water regulations and the California water quality criteria for beneficial uses. Tables 23 to 25 show the percent of times that the constituents in the test and control sites' water samples exceeded the selected water quality criteria. The 500 mg/l recommended municipal water criteria for total dissolved solids was exceeded 100 percent of the time in all phases of the control and test sites which included the irrigation waters, leachate from the lysimeters, and the groundwater.

The comparison of the water quality criteria with the irrigation waters indicated that barium, copper, nickel, zinc, and arsenic water quality criteria were not exceeded in any samples. The irrigation water applied to the control site and the effluent applied to the test site did not exceed the water quality criteria for chloride. Total and fecal coliform, boron, fluoride, nitrate, and selenium permissible limits were not exceeded by the control irrigation water; but the quality criteria for sulfate in 14 percent of the samples, cadmium in 50 percent, chromium in 20 percent, and lead in 36 percent were exceeded. The effluent at the test site exceeded the total coliform criteria in 72 percent of the samples, fecal coliform in 28 percent, boron in 38 percent, fluoride in 88 percent, nitrate in 9 percent and sulfate in 6 percent.

Comparing the results of the leachate values with the permissible criteria indicated that the following constituents at the test site exceeded the water quality criteria less often than at the control site: fluoride, 20 to 50 percent for the test site and 40 to 57 percent for the control site; sulfate, 38 to 60 percent compared to 88 to 100 percent for the control; and chromium at the 100 cm depth, 18 percent compared to 44 percent. The test site exceeded the water quality criteria more often than the control site leachate did for: chloride, 38 and 33 percent at the 50-and 100-cm depth in the test site leachate, and 0 and 75 percent in the control site, and was exceeded in 12 percent of the samples at the test site 300-cm level. The results may signify that the chlorides in the control site soil are readily leached, while much of the chlorides in the test site were retained in the soil. The nitrate criteria was exceeded 100 percent of the time in the test soil, and 75 to 83 percent of the time at the control site. The criteria were exceeded by chromium at the 50-cm depth, 36 percent in the test site soil compared to 11 percent at the control site. The percent of time that the total and fecal coliform,

TABLE 22: STATISTICAL SUMMARY OF BIOLOGICAL ORGANISM ANALYSIS OF THE INITIAL AND FINAL SOIL SAMPLES.

		Significant Level, Percent					
		96 - 99%			Less than 90%		
Comparison Relationship	Constituent	Mean Control	Values Test	% Diff.	Mean Control	Values Test	% Diff.
Initial Control/Test	Protozoa				2.9×10^3	3.3×10^3	+14
	Nematodes				32	54	+69
	Total Coliform				6.9×10^4	1.2×10^5	+74
	Fecal Coliform				<20	<20	0
Final Control/Test	Protozoa				2.3×10^3	4.5×10^3	+96
	Nematodes				13	3	-77
	Total Coliform				3.6×10^4	6.0×10^4	+67
	Fecal Coliform				8.2×10^3	2.2×10^4	+168
Control Initial/Final	Protozoa				2.9×10^3	2.3×10^3	-21
	Nematodes				32	13	-59
	Total Coliform				6.9×10^4	3.6×10^4	-48
	Fecal Coliform				<20	8.200	
Test Initial/Final	Protozoa				3.3×10^3	4.5×10^3	+36
	Nematodes	54	3	-94			
	Total Coliform				1.2×10^5	6.0×10^4	-50
	Fecal Coliform				<20	460	≥2,000

TABLE 23. COMPARISON OF THE IRRIGATION WATER ANALYSES WITH THE WATER QUALITY CRITERIA FOR MUNICIPAL AND IRRIGATION WATER SUPPLIES

Site	Source	Percent of Time Constituent Exceeded Water Quality Criteria							
		TC (100 MPN)[a]	FC (20 MPN)	TDS (500 mg/l)	B (1.0 mg/l)	Cl (250 mg/l)	F (1.0 mg/l)[b]	NO_3-N (10 mg/l)[c]	SO_4 (250 mg/l)
Test	Effluent	72	28	100	38	0	88	9	6
Control	Irrigation	0	0	100	0	0	0	0	14

Site	Source	Percent of Time Constituent Exceeded Water Quality Criteria								
		Ba (1.0 mg/l)[c]	Cd (0.01 mg/l)	Cr (0.05 mg/l)[c]	Cu (1.0 mg/l)	Ni (0.2 mg/l)[b]	Pb (0.05 mg/l)[c]	Zn (5 mg/l)	As (0.05 mg/l)[c]	Se (0.01 mg/l)[c]
Test	Effluent	0	61	14	0	0	48	0	0	6
Control	Irrigation	0	50	20	0	0	36	0	0	0

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[a] Permissible criteria for each constituent is given in parenthesis: water quality criteria for municipal water supplies, unless otherwise noted. Source: 3.

[b] Recommended maximum concentration in irrigation waters. Source: 4.

[c] Maximum contaminant level for the EPA interim primary drinking water regulations, 1977. Source: 5.

TABLE 24. COMPARISON OF THE LEACHATE ANALYSES WITH THE WATER QUALITY CRITERIA FOR MUNICIPAL AND IRRIGATION WATER SUPPLIES

Site	Lysimeter Depth (cm)	Percent of Time Constituent Exceeded Water Quality Criteria							
		TC (100 MPN)[a]	FC (20 MPN)	TDS (500 mg/l)	B (1.0 mg/l)	Cl (250 mg/l)	F (1.0 mg/l)[b]	NO_3-N (10 mg/l)[c]	SO_4 (250 mg/l)
Test	50	5	0	100	45	38	20	100	57
	100	9	0	100	57	33	30	100	60
	300	7	7	100	73	12	50	100	38
Control	50	0	0	100	33	0	57	83	88
	100	14	0	100	9	75	40	75	100

Site	Lysimeter Depth (cm)	Percent of Time Constituent Exceeded Water Quality Criteria								
		Ba (1.0 mg/l)[c]	Cd (0.01 mg/l)	Cr (0.05 mg/l)[c]	Cu (1.0 mg/l)	Ni (0.2 mg/l)[b]	Pb (0.05 mg/l)[c]	Zn (5 mg/l)	As (0.05 mg/l)[c]	Se (0.01 mg/l)[c]
Test	50	0	73	36	0	0	75	0	0	0
	100	0	45	18	0	0	79	0	0	12
	300	0	33	20	0	0	36	0	0	0
Control	50	0	70	11	0	0	80	0	0	11
	100	0	80	44	0	0	91	0	0	0

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[a] Permissible criteria for each constituent is given in parenthesis: water quality criteria for municipal water supplies, unless otherwise noted. Source: 3.

[b] Recommended maximum concentration in irrigation waters. Source: 4.

[c] Maximum contaminant level for the EPA interim primary drinking water regulations, 1977. Source: 5.

TABLE 25. COMPARISON OF THE GROUNDWATER ANALYSES WITH THE WATER QUALITY CRITERIA FOR MUNICIPAL AND IRRIGATION WATER SUPPLIES

Well			Percent of Time Constituent Exceeded Water Quality Criteria							
Site	Location	Depth	TC (100 MPN)[a]	FC (20 MPN)	TDS (500 mg/l)	B (1.0 mg/l)	Cl (250 mg/l)	F (1.0 mg/l)[b]	NO_3-N (10 mg/l)[c]	SO_4 (250 mg/l)
Test	On-site	Top	0	0	100	45	71	60	88	100
		Bottom	0	0	100	78	80	60	100	100
	Lateral	Top	15	0	100	9	100	89	100	100
		Bottom	12	0	100	33	87	75	100	100
	Downstream	Top	26	0	100	64	91	78	100	100
		Bottom	33	0	100	56	89	62	100	100

Well			Percent of Time Constituent Exceeded Water Quality Criteria								
Site	Location	Depth	Ba (1.0 mg/l)[c]	Cd (0.01 mg/l)	Cr (0.05 mg/l)[c]	Cu (1.0 mg/l)	Ni (0.2 mg/l)[b]	Pb (0.05 mg/l)[c]	Zn (5 mg/l)	As (0.05 mg/l)[c]	Se (0.01 mg/l)[c]
Test	On-site	Top	0	64	60	0	0	75	0	0	0
		Bottom	0	67	50	0	0	70	0	0	0
	Lateral	Top	0	73	38	0	0	70	0	0	0
		Bottom	0	50	43	0	0	89	0	0	0
	Down-stream	Top	0	55	38	0	0	80	0	0	0
		Bottom	0	62	33	0	0	89	0	0	0

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[a] Permissible criteria for each constituent is given in parenthesis: water quality criteria for municipal water supplies, unless otherwise noted. Source: 3.

[b] Recommended maximum concentration in irrigation waters. Source: 4.

[c] Maximum contaminant level for the EPA interim primary drinking water regulations, 1977. Source: 5.

cadmium, lead, and selenium were exceeded was similar for the test and control sites. Lead was exceeded at both the test and control sites about 80 percent of the time for the first 100 cm. At the 300-cm test field depth, lead exceeded the criteria only 36 percent of the time. The buildup of lead in the upper 100 cm of soil may have been due to the close proximity of the sites to the freeway and the subsequent retention of airborne lead from auto exhaust. The results at the 300-cm depth indicated that the lead was not readily leached.

The groundwater exceeded the water quality criteria for nitrate and sulfate 100 percent of the time, except for the nitrate at the top of the upstream (Well 1). The amount by which the total coliform exceeded the standards increased from none for the on-site well to 30 percent in the downstream well. Chromium contamination decreased from 55 to 35 percent from the on-site well to the downstream well. Lead pollution increased from 72 percent at the on-site well to 85 percent at the downstream well. The fecal coliform and the selenium levels were not exceeded.

AGRICULTURAL BALANCES

The agricultural use histories of the test and control sites are summarized on Tables 26 and 27, respectively. Ninety percent of the irrigation water on the control site was from on-site wells, and 10 percent from municipal wells. Irrigation with secondary effluent on the test site began in 1966, replacing Calleguas Municipal Water District water in all but two irrigations per year.

Some small differences in the amounts of different fertilizer and pesticides per hectare between the test and control sites are evident from Tables 26 and 27. Overall, the total quantity of fertilizers and pesticides per hectare was slightly greater on the control site. The pesticide applications are summarized in Table 28 for tomatoes and broccoli.

Crop Tissue Analysis

The results of the total crop tissue analyses are presented in Table 29. The concentration of most of the analyzed elements were within the expected range for normal agricultural crops shown in Table 30. A direct comparison of the concentration of various analyzed elements between crop tissues grown on the test and control sites was difficult because of the differences seen in crop genera, species and varieties. Nevertheless, the large differences seen in the concentration of particular elements were evaluated.

It was found that the uptake of boron in the edible parts of the tomatoes and broccoli was much greater in the control site plants; that is, an average of 0.35 mg/kg B was found in the test site plants compared to an average of 2.6 mg/kg B in the control site crops. There was no significant difference in the concentration of boron in the leaves. The tomatoes grown in the effluent irrigated soil contained more phosphorus: 41 and 88 mg/kg as PO_4 in the leaves and fruit, respectively, as compared to 24 and 34 mg/kg as PO_4 in the control site tomato leaves and fruit, respectively. Other constituents in which crop tissues in the effluent site plants were greater than those found

TABLE 26. TEST SITE AGRICULTURAL USE HISTORY

Year	Quarter	Crop	Irrigation (cm/yr)	Fertilizer (kg/ha)	Pesticide (amount/ha)
1977	Fa,W	Broccoli	174	449 (11-48-0) 449 (26-14-0)	2.3 l (Monitor 4) 3.5 l (Bravo 6F)
	Sp,Su	Tomato		560 (12-27-0)	2.3 l (Grithion 2S) 6.3 l (Thiodan 3) 2.2 kg (Lannate) 0.8 kg (Benlate)
1976	Fa,W	Broccoli	176	392 (11-48-0) 449 (26-14-0)	2.3 l (Monitor 4) 3.5 l (Bravo 6F)
	Sp,Su	Tomato		560 (12-27-0)	2.3 l (Grithion 2S) 6.3 l (Thiodan 3) 2.2 kg (Lannate) 0.8 kg (Benlate)
1975 - 1967 (repeated)	Fa,W	Broccoli	141	392 (11-48-0) 449 (26-14-0)	2.3 l (Monitor 4) 3.5 l (Bravo 6F)
	Sp,Su	Tomato		560 (12-27-0)	2.3 l (Grithion 2S) 6.3 l (Thiodan 3) 2.2 kg (Lannate) 0.8 kg (Benlate)

TABLE 27. CONTROL SITE AGRICULTURAL HISTORY

Year	Quarter	Crop	Irrigation (cm/yr)	Fertilizer (kg/ha)	Pesticide (amount/ha)
1977	Fa, Wi	Broccoli	151	449(11-48-0)	1.8 l (Bravo 6F)
				449(26-14-0)	4.7 l (Monitor 4)
	Sp, Su	Tomato		505(21-7-14)	2.3 l (Grithion 2S)
					6.3 l (Thiodan 3)
					2.2 kg (Lannate)
					2.4 kg (Benalate)
1976	Fa, Wi	Spinach	147	449(11-48-0)	1.8 l (Bravo)
				449(26-14-0)	4.7 l (Monitor 4)
	Sp, Su	Tomato		505(21-7-14)	2.3 l (Grithion)
					6.3 l (Thiodan 3)
					2.2 kg (Lannate)
					0.8 kg (Benalate)
1975-	Fa, Wi	Broccoli	139	393(11-48-0)	1.8 l (Bravo 6F)
1966				449(26-14-0)	4.7 l (Monitor 4)
(repeated)	Sp, Su	Tomato		505(21-7-14)	2.3 l (Grithion 2S)
					6.3 l (Thiodan 3)
					2.2 kg (Lannate)
					0.8 kg (Benalate)

TABLE 28. CONTROL AND TEST SITES PESTICIDE APPLICATION, 1965-1975

Pesticide[b] Parameters	Crop[a,c] Tomato	Tomato	Tomato[d]	Broccoli	Broccoli
Common Name[b]	Benelate	Guthion-25	Thiodon-3	Monitor-4	Bravo GF
Chemical Name[b]	Benomyl	0.0-Dimethyl S-Phosphorodithioate	Pyrenone	O.S-Dimethyl phosphoramidithioate	Chlorothaloni
Insecticide or Pesticide[b]	Pesticide	Insecticide	Insecticide	Insecticide	Insecticide
Manufacturer[b]	DuPont	Chem Grow	Canadian Hoscht, Ltd.	Chem Grow	Diamond Shamrock Co.
Recommended Dose (l/ha, unless otherwise noted)[b]	0.62-2.5 kg	2.5-3.7	6.5	2-4	2-2.5
Rate of Application (l/ha, unless otherwise noted)[a]	0.86 kg	2.5	3.0	2.5	1.5
Number of Applications[b]	3	1	1	1	2
Contact Time (days)[b]	7-14	14	7	21	7-10
Remarks[b]		Toxic to fish, birds, and wildlife. Keep out of water bodies. Not applied when runoff is likely to occur.	Toxic to fish birds, and wildlife. Keep out of water bodies. Not applied when runoff is likely to occur.	Toxic to fish, birds, and wildlife. Keep out of water bodies. Not applied when runoff is likely to occur.	Toxic to fish, birds, and wildlife. Keep out of water bodies. Not applied when runoff is likely to occur.

[a] Information supplied by site farmer.

[b] Information from manufacturers.

Note: [c] The test and control sites farmer uses the same insecticides, pesticides, and application rates on similar crops.

[d] For 1976.

TABLE 29. CROP TISSUE ANALYSES

				MPN/g		Constituent (mg/kg)								
Site	Date Harvested	Type		Total Coliform	Fecal Coliform	B	Cl	NO_3-N	P-PO_4	S-SO_4	K	Na	Ca	Mg
Test	July 1977	Tomato	Leaves	0	0	0.40			41	1,190	31,200	4,200	23,600	11,500
			Fruit	0	0	0.19			88	24	18,100	6,100	23,700	14,500
	Dec. 1977	Broccoli	Leaves	10	0	0.45			25	99	48,500	23,500	22,400	15,900
			Head	5	0	0.5			30	66	76,500	8,150	2,400	10,400
Control	Oct. 1976	Spinach	Leaves	200	0	37	88	165	6,390	355	7,530	22,800	4,950	7,000
	July 1977	Tomato	Leaves	0	0	0.55			24	3,650	52,300	5,300	2,350	6,230
			Fruit	0	0	1.76			36	113	37,900	900	825	3,520
	Jan. 1978	Broccoli	Leaves	0	0	0.75			20	158	86,200	16,200	20,600	16,800
			Head	0	0	3.5			12	57	24,800	4,250	2,200	10,800

				Constituent (mg/kg)											
Site	Date Harvested	Type		Ba	Cd	Cr	Cu	Fe	Mn	Mo	Ni	Pb	Zn	As	Se
Test	July 1977	Tomato	Leaves	42	5	3.1	210	990	46	< 10	280	27	71	2.1	< 0.5
			Fruit	28	< 2	2.0	62	280	4	< 10	5	27	35	2.1	0.8
	Dec. 1977	Broccoli	Leaves	62	< 2	< 2.0	18	398	178	< 25[a]	8	10	68	3.4	
			Head	29	< 2	< 2.0	20	405	75	< 25	16	11	152	4.5	
Control	Oct. 1976	Spinach	Leaves	30	9.2	22	22	512	116	68	b	50	110	< 0.5	< 0.5
	July 1977	Tomato	Leaves	13	6	6.6	22	1,070	180	< 10	19	48	45	1.1	0.3
			Fruit	5	< 2	3.9	20	490	11	< 10	13	19	87	1.0	0.1
	Jan. 1978	Broccoli	Leaves	61	< 2	< 2	14	308	264	40	8	12	84	6.1	
			Head	47	< 2	< 2	12	344	84	< 25	15	16	186	8.0	

[a] The value is an average of four analyses, one or more which were less than the detectable limit of 10 mg/kg.

[b] Nickel crucibles were initially used to digest the crop samples, therefore nickel was not determined.

TABLE 30. EXPECTED RANGE OF ELEMENTS IN HEALTHY CROP TISSUE[a]

Crop	Constituent (mg/kg) As	B	Cd	Cr	Cu	Mo	Ni	Pb	Se	Zn
Broccoli	0-1	10-50	0-3	0-1	1-20	1-50	0.1-3	0-10	0-2	30-100
Corn	0-1	10-50	0-3	0-3	1-30	1-5	0-3	0-10	0-1	20-200
Cotton	0-1	10-50	0-3	0-1	1-30	1-10	0-2	0-10	0-1	10-200
Forage	0-1	10-100	0-3	0-1	1-10	1-5	0-5	0-5	--[b]	20-100
Small grain	0-2	10-60	0-1	0-1	1-40	1-10	--	0-10	--	30-100
Sorghum	0-1	10-70	0-3	0-2	1-30	1-5	0-3	0-10	0-1	10-100
Spinach	0-1	10-70	0-3	0-1	1-20	1-10	0.1-1	0-10	0-1	30-150
Tomato	0.01-1	10-100	0-3	--	1-30	0.7-5	0-3	1-10	0-2	40-200

Crop	Constituent (% or 10^4 mg/kg) Ca	K	Mg	N	Na	P
Broccoli	0.1-1.5	1-3	0.5-1.5	1.3	--[b]	0.3-1
Corn	0.1-1.5	1-2	0.5-1.5	1-2.5	--	0.1-1.5
Cotton	0.5-1.5	0.7-1.5	0.2-1	0.4-1.5	--	0.5-1
Forage	0.2-1.2	0.1-1	0.1-1	0.2-0.7	--	0.2-1
Small grain	0.4-1	1.3	0.2-1	0.4-1	0.04-1	0.2-1
Sorghum	0.1-1.5	1-2.5	0.5-1.5	0.5-2.5	--	0.1-1.5
Spinach	0.1-2	1-3	0.5-1.2	1-3.5	--	0.3-1
Tomato	1.0-2.5	0.2-1	0.7-1.5	1-3	--	0.3-1

[a] Sources: 6-26.
[b] Not determined.

in the control site crops included: sodium (6,100:900 mg/kg in the fruit); magnesium (11,500 and 14,500 mg/kg for the control grown leaves and fruit); barium (the test leaves and fruit contained 42 and 28 mg/kg, and the control site crops contained 13 and 5 mg/kg, respectively); zinc (the test-grown leaf tissues contained 71 mg/kg while the control tissues had 45 mg/kg Zn); and arsenic (the test leaves and fruit contained 2.1 and 2.1 mg/kg, whereas the control samples had 1.1 and 1.0 mg/kg, respectively).

The uptake of the following constituents was lower in the test site tomatoes than the control site crop: sulfur (test leaves and fruit equalled 1,190 and 24 mg/kg as SO_4, and the control-grown tissues contained 3,650 and 113 mg/kg as SO_4); chromium (3.1 and 20 mg/kg were found on the test site tomato leaves and fruit, respectively, while the control site leaves and fruit equalled 6.6 and 3.9 mg/kg); iron (the test site tomato fruits had 280 mg/kg Fe, while 490 mg/kg Fe was found in the control site fruits); manganese (the test site leaves and fruits contained 46 and 4 mg/kg, respectively, while the corresponding control site samples contained 180 and 11 mg/kg); nickel (the test site tomato fruit contained 5 mg/kg while 13 mg/kg was found for the control site fruit); lead (the leaves grown in the test soil had 27 mg/kg, whereas the control leaves contained 48 mg/kg; and zinc (the test fruit contained 35 mg/kg and the control fruit contained 87 mg/kg).

The tomato leaves contained from 10 to 30 times more copper (210 mg/kg in the test crop and 22 mg/kg in the control-grown leaves) and nickel (280 mg/kg in the test leaves, and 19 mg/kg in the control crop) in the test plants; whereas, the controlled grown tomato leaves contained about 5 times more manganese (46 mg/kg in the test compared to 180 mg/kg on the control crop). There was no significant difference for all the other constituents. The test site broccoli leaves contained less magnanese (178 mg/kg compared to 264 mg/kg) than the control crop. There were no other significant differences.

Water Balance

The water balance estimate for the 16 ha test site and the 20 ha: control site is given in Table 31. Precipitation and irrigation data, based on treatment plant records were estimated for the test site during the seven-year period, 1971 through 1977. The potential evapotranspiration losses were calculated for broccoli (50.8 in the winter) and tomato (50.8 in the summer). The remaining irrigated water entered the soil and percolated into the upper groundwater. The irrigation procedure was the same for both test and control sites, and consisted of using sprinklers at the time of pre-planting and initial planting, followed by furrow irrigation when the plants were growing above ground. Precipitation, irrigation, and evapotranspiration data for the control site were similar to those shown for the test site on a per hectare basis. Table 32 gives the nutrients supplied by water effluent irrigation for the test and control sites. For the 13-year period from 1965 through 1977, the test site effluent nitrogen and potassium nutrient values were about double those found in the control site irrigation water. The test effluent provided eight times more phosphorus than the control site irrigation water.

TABLE 31. WATER BALANCE - YEARLY AVERAGE FOR PERIOD 1971 TO 1977

	Precipitation			Irrigation		Total Effective Water (cm) F[e]	Average Evapo-transpiration (cm)[d] G	Average Leachate (cm) H[f]
Site	Total (cm) A	Effective[a] (cm) B	Total 1,000 cu m) C	Total[b] (cm) D	Effective[c] (cm) E			
Test[g]	29	23	256	160	151	174	102	72
Control[h]	29	23	308	153	152	175	102	73

[a] Runoff coefficient is percent of precipitation lost through runoff. Runoff coefficient: 0.1.
[b] Estimating that 8,000 M^3 per day of the treated effluent is diverted by percolation, evaporation, etc.
[c] Irrigation efficiency, the percent of total applied which is not lost to runoff, was estimated to be 82 percent.
[d] Source: 24.
[e] F = B + E, Please refer to column headings, line 5 above.
[f] H = F - G, Please refer to column headings, line 5 above.
[g] Area: test area, 16 ha; total effluent irrigated area, 182 ha.
[h] Area: 20 ha.

TABLE 32. SUMMARY OF ESTIMATED TOTAL WATER USED AND NUTRIENT SUPPLIED BY THE IRRIGATION WATER - YEARLY AVERAGE FOR PERIOD OF 1965 TO 1977

Site	Precipitation[a]		Irrigation[b]		Total Water		Fertilizer Value in Effluent Irrigation[c]								
	(cm/crop)[4]	(cm/yr)	(cm/crop)[d]	(cm/yr)	(cm/crop)[d]	(cm/yr)	(mg/l)			(kg/ha/crop)[d]			(kg/ha/yr)		
							N	P	K	N	P	K	N	P	K
	A	B	C	D	E[e]	F[f]	G			H[g]			I[h]		
Test	18	35	78	156	95	191	25	10	20	195	78	156	391	156	312
Control	18	35	77	155	94	189	13	2	8	101	9	76	201	19	151

[a] Weather Data: Camarillo Fire Station.
[b] Site farmer.
[c] Estimated to be the same as existing irrigation water.
[d] Based on two crops per year.
[e] E = A + C.
[f] F = B + D.
[g] H = C + G.
[h] I = D + G.

(e–h) Please refer to column headings line 6 above.

Note: All numbers were rounded off to nearest whole number.

Agricultural Balances and Comparisons

The nitrogen, phosphorus, and potassium nutrient quantities applied to the test and control sites from 1965 to 1977 are summarized on Table 33. Detailed water and nutrient balance calculations are given in Appendix G. There was a net increase in all three nutrients in the soil sampled at the test site, and a net decrease in nitrogen and potassium in the control site soil samples. The test site effluent irrigation water provided twice as much nitrogen and potassium, and eight times as much phosphorus as the control site conventional irrigation water. Overall, the test site received more nutrients than the control site. In addition to the irrigation waters, nutrients were added as fertilizer to both sites. The total input during the 13-year period for the test site was, for N, P and K (26, 78, and 33 percent, respectively), greater than the total input to the control site.

The test and control site crop yield and nutrition data are presented in Appendix G and are summarized in Table 34. The combined nutrient uptake efficiency at the control site (61 percent) was about 50 percent greater than at the test site (43 percent). Crop uptake for all three nutrients was greater at the control site than at the test site. The quantity of each of the three available nutrients used by plants at the test and control sites ranged from 2.5 percent for nitrogen to 11 percent for potassium. Thus, the difference in crop uptake efficiency was not due to differences in uptake quantities, but rather to the total amounts of available nutrients exceeding the uptake capacity required for the crops. Crop yields on the test site were 12 and 4 percent greater for tomatoes and broccoli, respectively, than on the control site over a 13-year period. The test and control site crops were tested by eight persons to compare taste and appearance. The test site crops tasted and looked as good as or better than the same control site crops.

Economic Analysis

Crop cost and income analyses are summarized in Table 35. The average profit per acre for the last three years shown was greater for similar crops on the test site than for the control site; the cost for the irrigation water on the control site was the primary cause of the higher costs that resulted in lower profits. The test site effluent nutrient value was a second beneficial effect.

The annual dollar value per hectare of nutrients available in the reclaimed effluents applied at the test site were estimated to be: 1977 - $595; 1976 - $600; and 1975 - $484. The equivalent values were based on the cost to purchase an equal quantity of nutrients as commercial fertilizer. The total available nutrients were not used since some nutrients percolated through the soils and thus remained in the leachate and entered the groundwater.

An evaluation of the effective added values of nutrients in the effluent and irrigation water are summarized in Table 36. Since the farmer also provided ample

TABLE 33. SITE SUMMARY NUTRIENT BALANCE (1965-77)

Input/Output	Total Nutrients (kg/ha/13 yr period)					
	Test Site			Control Site		
	N	P	K	N	P	K
Input						
Fertilizer	2,840	5,254	0	3,470	3,783	923
Irrigation	4,765	1,907	3,805	2,587	243	1,946
Total Input	7,605	7,161	3,805	6,057	4,026	2,869
Output						
Crop Uptake	2,754	2,697	1,932	2,655	2,774	2,152
Leachate	4,367	157	1,497	4,007	320	1,265
Atmosphere	130	0	0	130	0	0
Total Output	7,121	2,854	2,441	6,792	3,094	3,417
Topsoil Residual	354	4,307	376	-735[a]	932	-548

[a] Negative value indicates topsoil depletion of nutrient.

TABLE 34. SUMMARY OF CROP NUTRIENT UPTAKE (1965-77)

Site	Estimated Nutrient Supplied (kg/ha/yr)			Estimated Nutrient Uptake[a] (kg/ha/yr)			Uptake Efficiency %			Combined Nutrient Uptake Efficiency %	Crop Yield 1,000 kg/ha/yr
	N	P	K	N	P	K	N	P	K		
Test	584	547	291	212	208	149	36	42	52	43	8.4[b] 2.7[c]
Control	465	308	221	218	213	166	44	69	70	61	7.5[b] 2.6[c]

[a] Yearly average during thirteen year period.
[b] Tomatoes.
[c] Broccoli.

TABLE 35. TEST AND CONTROL SITES CROP COSTS AND SALES COMPARISON ($/ha)[a,b]

Year 19___	Site & Crop	Cultivation	Irrigation Water	Fertilizing[c]	Harvesting Packaging, & Selling	Land[d]	Total Costs	Crop Sales Price	Estimated Profit
77	Test Site								
	Tomato	775	103[e]	92	1,306	432	2,708	1,089	-1,619
	Broccoli	944	68[e]	184	495	309	2,000	2,174	174
	Control Site								
	Tomato	775	445	92	1,306	432	3,050	1,089	-1,961
	Broccoli	944	272[f]	184	495	309	2,138	1,976	- 162
76	Test Site								
	Tomato	720	87[e]	83	1,221	432	2,543	3,503	960
	Broccoli	883	61[e]	172	430	309	1,855	2,179	324
	Control Site								
	Tomato	720	361	83	1,221	432	2,817	3,503	686
	Spinach	457	296	166	0	309	1,228	1,482	254
75	Test Site								
	Tomato	674	80[e]	79	1,136	432	2,401	4,095	1,694
	Broccoli	821	53[e]	184	430	309	1,797	2,870	1,073
	Control Site								
	Tomato	674	361	79	1,136	432	2,682	4,095	1,413
	Broccoli	821	241	184	430	309	1,985	2,870	885

(continued)

TABLE 35 . (continued)

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[a] This table is based on 1975–1978 costs. Costs for the years 1965–1974 would be relatively similar, but vary with the economic factors for those years.

[b] From source 26.

[c] From Table 33 on Nutrient Balances for Camarillo, California sites.

[d] Based on $61.75/hectare-month for appropriate growing period, from Source 1.

[e] Farmer uses fresh water for sprinkler irrigation at planting time, and for final irrigation before harvest.

[f] The final irrigation and fertilizer application were omitted due to rain.

TABLE 36. EFFECTIVE VALUE OF WASTEWATER NUTRIENTS (1965-77)

Nutrient Source/Use	Test Site N	Test Site P	Test Site K	Control Site N	Control Site P	Control Site K
Fertilizer Supply (kg/ha/yr)	2,840	5,254	0	3,470	3,701	923
Crop Uptake (kg/ha/yr)	2,764	2,697	1,932	2,835	2,774	2,152
Net Supplied by Wastewater[a] (kg/ha/yr)	--	--	1,932	--	--	1,229
Maximum Value of Nutrient Supplied by Irrigation[b] ($)	0	0	1,275	0	0	811
Total Value (1965-1977) ($)			1,275			811
Avg. Value per Year ($)			98			62

[a] Assumes that all of the crop intake in excess of fertilizer applied was from effluent or regular irrigation water. Some of the nutrients may come from the soil, but the amount is not known.

[b] 1965 to 1977 total value.

commercial nitrogen and phosphate fertilizer, it was assumed that no effluent nitrogen and phosphorus would be taken up by the plants. This assumption provided a conservative estimate of the effluent nutrient value. It was assumed in this analysis, however, that all of the potassium used by the crops came from the effluent.

OTHER ENVIRONMENTAL OBSERVATIONS

The Camarillo Sanitary District's Water Reclamation Plant was located in primarily a rural area that was intensively farmed to produce three crops per year of high value garden vegetables. The plant was a modern, well operated facility, and the well stabilized secondary effluent was chlorinated, without significant aesthetic problems. Odors resulting from the plant or test site were not noticeable. No flies attributable to the effluent were observed at the test site.

A review and comparison of illness among farm workers at the test site and treatment plant employees with control site farm workers showed no difference in illness that could be attributed to the use of effluent for crop irrigation. The use of furrow irrigation when plant growth was above ground reduced the potential for contamination that might occur if spray irrigation was used.

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SECTION 7

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APPENDIX A

SITE DESCRIPTION

GENERAL AREA CHARACTERISTICS

Introduction

The Camarillo Sanitary District's reclaimed water irrigation project area is situated in Ventura County, California, approximately 24 km east of the City of Oxnard and the Pacific Ocean as shown on Figure A-1. The following sections summarize some of the available information about the local environment, agriculture, and wastewater treatment.

Climate

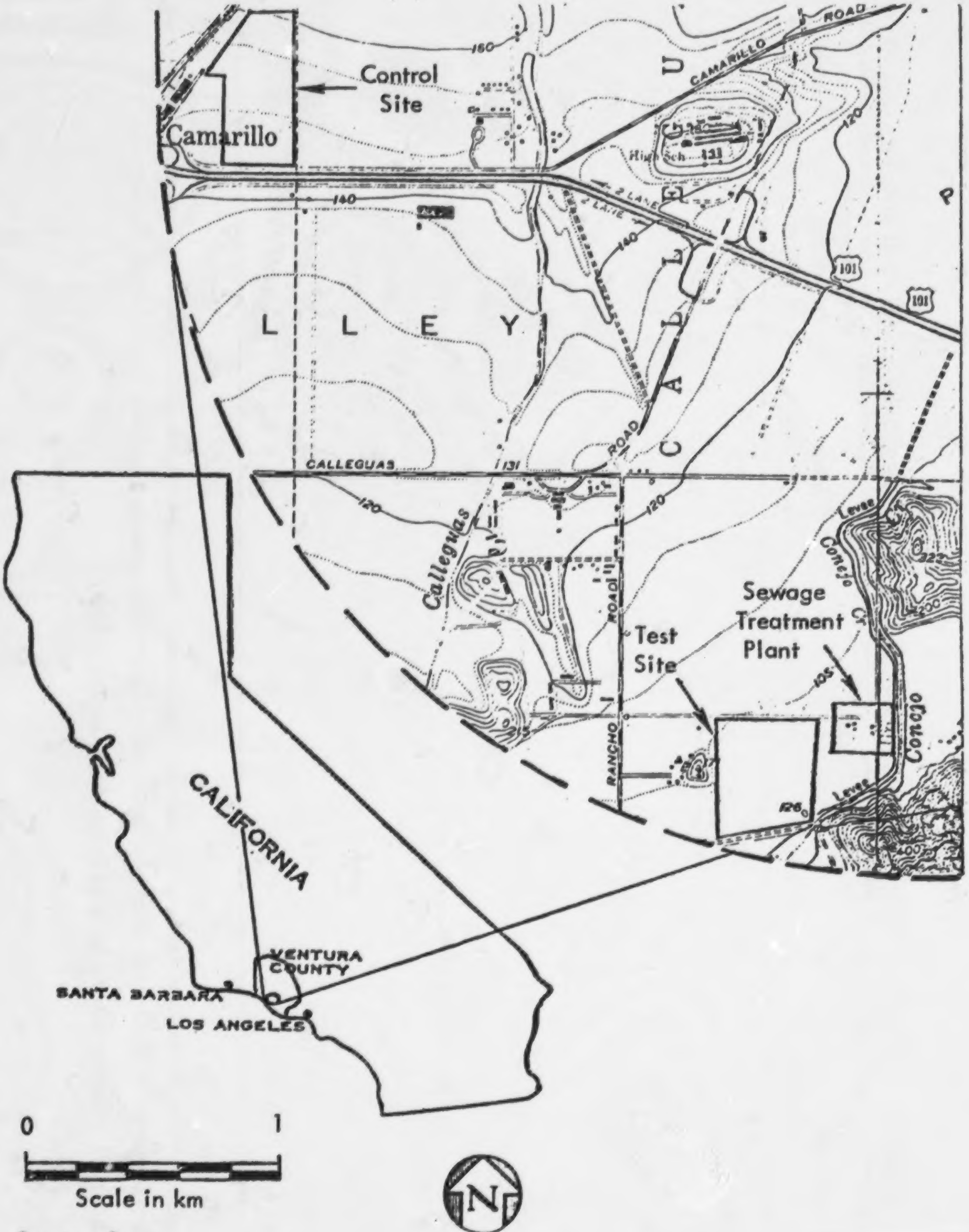
The average normal temperatures recorded at nearby weather stations in the Ventura Regional County Sanitation District (VRCSD) are given in Table A-1. Temperature extremes in the inland areas are greater than those near the Pacific Ocean, even though average annual temperatures are almost identical.

Prevailing winds (see Table A-1)arepredominantly west, northwest onshore and averaged 10 kilometers per hour. The wind directions often experience diurnal reversal (i.e., the wind direction reverses and blows offshore from the canyons during the evenings). During the May and June spring period, the wind direction reverses and results in prevailing offshore southerly winds. The diurnal pattern again prevails when the evening breezes blow onshore.

Precipitation varies from a minimum of 30 cm in the vicinity of Camarillo and the lowland areas.

Potential annual water evapotranspiration ranges from 76 cm in coastal areas to 71 cm in the interior; during the all-year agricultural growing period, evapotranspiration ranges from 74 cm along the coast to about 50 cm in inland areas.

The local dry season is normally from early May through the end of November but supplemental water irrigation is practiced throughout the year.


Control Site
Camarillo
CAMARILLO ROAD
High Sch.
2 LANE
101
L L E Y
C A L L E
CALLEGUAS
ROAD
Calleguas
RANCHO ROAD
Test Site
Sewage Treatment Plant
Conejo
Levee
CALIFORNIA
VENTURA COUNTY
SANTA BARBARA
LOS ANGELES
0
1
Scale in km
N

Source: 1.

Figure A-1. Study area – test and control farm sites.

TABLE A-1. VENTURA COUNTY, CALIFORNIA -- LOCAL TEMPERATURE NORMS AND WIND PATTERNS

Period	Average Temperatures (degrees C)			Wind Patterns[a]		
	Santa Paula	Oxnard	Ojai	Mean Speed (kph)	Prevailing Direction	Fastest Speed (kph)
Jan.	12	12	10	9.2	WNW	59
Feb.	14	12	11	10.1	W	64
Mar.	14	13	13	11.1	W	56
Apr.	14	14	15	12.2	W	71
May	17	15	17	12.1	S	48
June	18	16	19	11.4	S	34
July	20	18	23	10.9	WNW	37
Aug.	20	18	23	10.6	WNW	37
Sept.	19	18	22	10.1	WNW	37
Oct.	17	17	18	9.7	WNW	60
Nov.	14	15	14	9.3	WNW	56
Dec.	11	13	11	8.8	WNW	63
Annual	16	15	16	10.5	WNW	71

[a] Based on available 12-year data from Los Angeles County; no records available from Ventura County.

Source: Weather Bureau located in Los Angeles, California.

Geology

The Camarillo sites (test and control) are located in the Transverse Range geomorphic province, in the Pleasant Valley Basin. Geological formations present in this province include igneous and metamorphic rocks of pre-Cretaceous age, marine and continental sediments of Cretaceous to Recent age, and volcanic rocks of Tertiary age. The site is bordered on the south and east by outcrops of Miocene volcanics in or near the Santa Monica Mountains. These included basaltic flows and agglomerates with some interbedded sediments. Basaltic and andesitic intrusions are also associated with the volcanics. Formations in the Pleasant Valley Basin include recent and upper Pleistocene alluvium underlain by the marine San Pedro and Santa Barbara formations. These formations in turn are underlain by the Pico and Santa Margarita formations, Modelo Shale, and volcanics of Miocene age. All formations in the Pleasant Valley Basin area, with the exception of recent deposits, are to some extent deformed. Structures in the area, including fold axes and faults, trend in an east-west direction.(See Figure A-2.)

Soils

Soils of Ventura County vary markedly in type, composition, and depth, as well as in other physical and chemical properties, in accordance with the origin of the parent material, nature of deposition, and age and degree of development since the time of deposition. In general, the soils could be divided into three broad groups: (1) residual soils, which have been developed in place from the disintegration and weathering of consolidated rocks, both of sedimentary and basic igneous origin, and which comprise a relatively small area, occupying the rolling hills and ridges at the perimeter of the interior valleys; (2) old valley filling and coastal plain soils, which are derived from elevated, unconsolidated waterlaid deposits which have undergone marked changes since their deposition, and which occur both on hills and rolling lands, and on smooth and eroded marine or stream terraces, and (3) recent alluvial soils, which are derived from sediments that have undergone little or no change or internal modification since their deposition, and which cover nearly the entire coastal plain of the Santa Clara River Valley and its tributaries. Recent alluvial soils comprise the largest area in the County presently developed to either irrigated agriculture or urban development. These soils have their origin in a variety of materials, including shale, sandstone, conglomerate, basic igneous rocks, and old valley filling deposits (28).

A detailed description of the characteristics of the project area soil conditions are presented in the Test and Control Site sections.

Hydrogeology

The sites are located within the Pleasant Valley Basin of the Santa Clara River hydrologic unit. The principal aquifers within this basin are deep and composed of continental and marine sediments of Recent and Pleistocene age and the underlying San Pedro and Santa Barbara formations. In certain areas, wells are supplied from fractured

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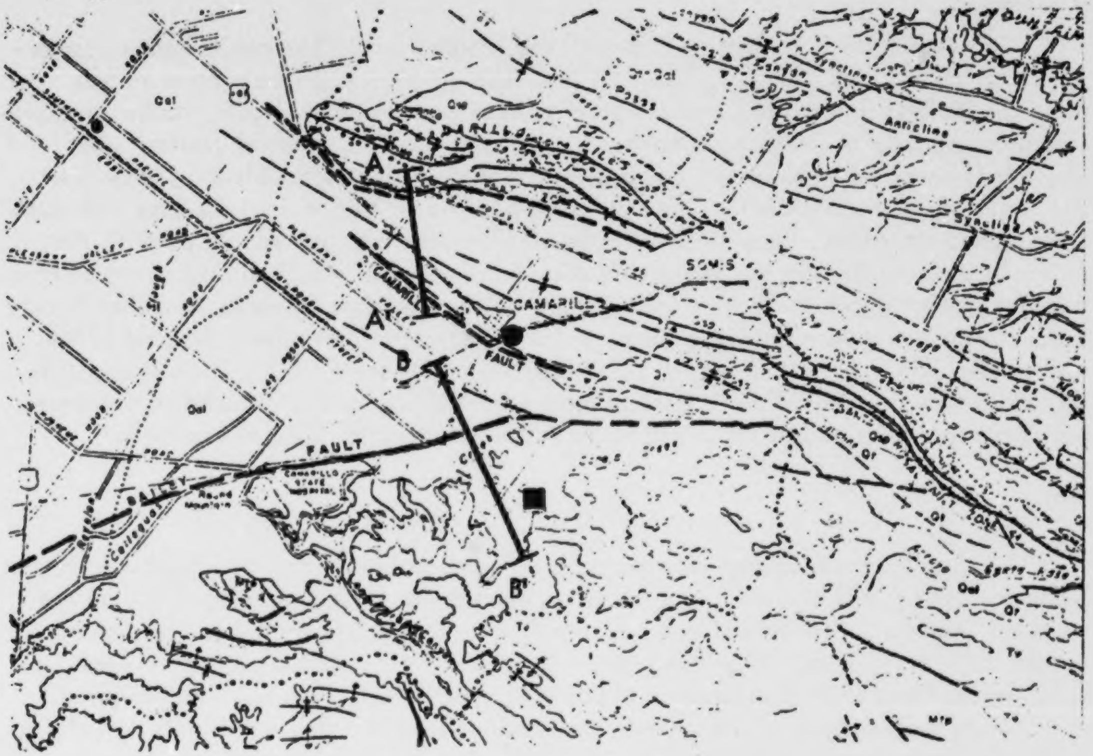

A
A'
B
B'
CAMARILLO
SOMIS
FAULT
Qal
Anticline
Syncline
Arroyo
Camarillo State Hospital
Round Mountain
Tv

0 4
Scale in km

Source: 28.

Legend

● Control site

■ Test site

— — Fault

Figure A-2. Geologic map of project area.

volcanic rocks of the Tertiary system, or from fissures in crystalline or consolidated rocks of pre-Quarternary age. The Fox Canyon member of the lower Pleistocene San Pedro formation supplies most of the water used in the Pleasant Valley Basin. Groundwater is also obtained from sand and gravel lenses in Recent and Upper Pleistocene deposits and, to a minor extent, from aquifers in the Santa Barbara formation (underlying the San Pedro formation) and from fractures and fissures in volcanic rocks along the southeasterly portion of the basin. Both the Fox Canyon aquifer and aquifers in the Santa Barbara formation are confined by sediments of low permeability. Groundwater from the Oxnard Forebay Basin moves under pressure, through the Fox Canyon aquifer to the Pleasant Valley Basin.

Aquifers in the Pleasant Valley basin are supplied primarily by subsurface inflow from adjacent basins: from the Oxnard Forebay Basin through the Fox Canyon aquifer, and from the East Las Posas and Santa Rosa Basins in the Calleguas-Conejo hydrologic unit (as shown in Figure A-3). Wells perforated in the Fox Canyon aquifer generally yield the most water. The maximum is about 13,000 liters per minute, and the average about 3,800 liters per minute, with a drawdown of about 3 to 15 meters. Wells perforated in both volcanic rocks and shallower aquifers and those only in shallower aquifers generally yield up to about 3,800 liters per minute, with an average of about 1,500 liters per minute, and a drawdown of 10 to 23 meters.

Groundwater

Because the Camarillo City wells draw from deep aquifers, the return flow irrigation and wastewater percolation do not affect the municipal water quality. Table A-2 shows chemical analyses of typical groundwater in the study area, and California Health Department standards.

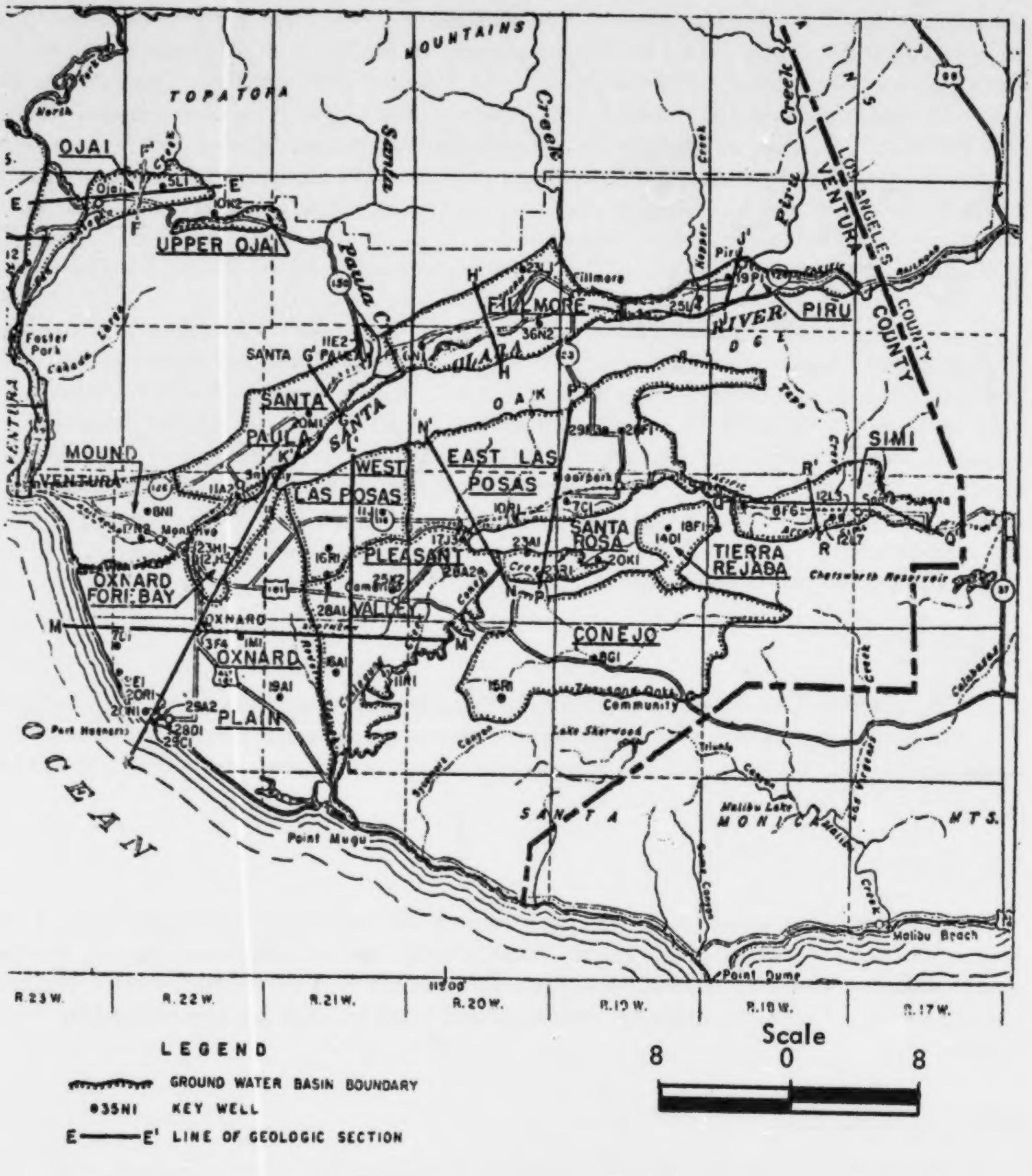
Agriculture

Both the climate and soil of the area favored all year farming of sugar beets, lima beans, broccoli, cabbage, cauliflower, head lettuce, celery, pimiento peppers, spinach and tomatoes. It is common practice to fertilize the sub-soil before furrowing. Typical characteristics of local agricultural water use and yield by crop are summarized in Table A-3.

Wastewater Treatment

The Camarillo Sanitary District wastewater reclamation plant is located in the southeast corner of the District near the intersection of Lewis Road with Conejo Creek (see Figure A-1). The surrounding area is still predominantly agricultural with the nearest subdivisions over a mile away.

The plant is an 18,000 cubic meters per day conventional activated sludge plant, with primary and secondary clarification, chlorination, polishing ponds and a storage



TOPATOPA
MOUNTAINS
OJAI
UPPER OJAI
FILLMORE
PIRU
SANTA PAULA
MOUND
VENTURA
WEST LAS POSAS
EAST LAS POSAS
PLEASANT VALLEY
SANTA ROSA
TIERRA REJADA
SIMI
OXNARD FOREBAY
OXNARD PLAIN
CONEJO
OCEAN
SANTA MONICA MTS.
VENTURA COUNTY
LOS ANGELES COUNTY
Point Mugu
Point Dume
Malibu Beach
Port Hueneme
Thousand Oaks Community
Chatsworth Reservoir
R.23W.
R.22W.
R.21W.
R.20W.
R.19W.
R.18W.
R.17W.
LEGEND
GROUND WATER BASIN BOUNDARY
●35N1 KEY WELL
E——E' LINE OF GEOLOGIC SECTION
Scale
8
0
8

Source: 28.

Figure A-3. Ventura County groundwater basin boundaries, 1953.

TABLE A-2. CHEMICAL ANALYSES OF GROUND AND SURFACE WATER SUPPLIES

Inorganic Chemicals (mg/l)	Calif. Health Dept. Limiting Concentration	Typical Groundwater Camarillo Water Department	
		Well "A"[a]	Well "B"[b]
Arsenic	0.01	< 0.005	< 0.005
Barium	1.0	-	-
Bicarbonate	-	226	232
Boron	-	0.2	0.2
Cadmium	0.01	-	-
Calcium	-	100	66
Chromium	0.05	-	-
Chloride	500[c]	56	38
Copper	1.0	< 0.1	< 0.1
Cyanide	0.2	-	-
Fluoride	0.6 - 1.7[d]	0.5	0.5
Iron	0.3	< 0.1	< 0.1
Lead	0.05	< 0.05	< 0.05
Magnesium	-	27	23
Manganese	0.05	< 0.05	< 0.05
Mercury	0.005	-	-
Nitrate	10	1.0	0.0
Selenium	0.01	< 0.01	< 0.01
Silver	-	-	-
Sodium	-	79	76
Sulfate	500.0[c]	247	170
Zinc	5.0	0.2	0.2
Total Dissolved Solids	1,000[c]	736	605

[a] Sampled 10/76.
[b] Sampled 1/77.
[c] Upper limit.
[d] Temperature dependent.

Source: 29.

TABLE A-3. VENTURA COUNTY CHARACTERISTICS OF CROP YIELD AND WATER USE[a]

Crop	Season (mo)	Water Use Seasonal Mean (cm/hectare)	Production[b] (kg/hectare)	Mean Consumption
Sugar beets	Dec.-Oct.	61	150(1974)	
Broccoli	Aug.-Jan.	20	1,300	
Cabbage	July-Dec.	20	1,255	
Cauliflower	Dec.-May July-Jan.	20	911	
Head lettuce	Aug.-Nov.	20	1,025	
Spinach	Dec.-May	10	--	
Lima beans	May-Sept.	25	6,044	
Celery	Year-round	76	3,537	
Pimento peppers	March-Oct.	46	--	
Tomatoes	April-Nov.	36-56	> 2,023	

[a] Information supplied by Farm Advisor, University of California, Cooperative Extension.

[b] 1975 data.

basin. The average flow during this study was approximately 8,500 cubic waters per day. Sludge digestion is accomplished by either two-stage heated anaerobic digestion or aerobic digestion. The Pacific Sod Company transports the dried sludge from the plant site for use as a soil conditioner in growing sod.

Well controlled, industrial waste discharges contribute approximately ten percent of the flow and presents minimum water quality problems. Camarillo plans to limit future industrial growth to light industry in order to help protect their area from environmental degradation.

Table A-4 presents the plant's reported 1975 influent and effluent water quality characteristics, including irrigation reuse and creek discharge flows. Discharge requirements for disposal of the plant's effluent are shown in Table A-5.

TEST SITE

General

The Camarillo test site receiving reclaimed effluent is 16 hectares of a 182 hectare farm located at Rancho Road, along Conejo Creek, approximately 0.6 km west of the treatment plant as shown in Figure A-1. The farm is irrigated with a piped effluent, pumped directly from the treatment plant or the elevated open storage reservoir. Excess plant effluent is discharged into Conejo Creek.

Geology

The test site is located over a buried valley with a buried ridge to the west. Earth materials underlying the site consisted of a western thickening wedge of Upper Pleistocene alluvium composed of fines with sand and gravel lenses (see Figure A-4).

The thickness of the top-lying alluvium is approximately 52 m in the western portion of the test site. The strata thins out eastward and southward against the Santa Monica Mountains and westward to an unknown thickness over a buried ridge. Available well logs indicate an increase in alluvium thickness northward from 52 m at the southwestern part of the site to 106 m some 850 m away.

Soils

Three types of soils are reported on the site by the U. S. D. A. (see Figure A-5). These include soils from the Mocho Series, Hambright Series, and Hueneme Series.

Mocho Loam (MoA) covers the majority of the site. This soil is found on the alluvial plain and is derived predominantly from sedimentary rocks. It is composed of a grayish-brown, calcareous loam 1.5 m or more deep. It is about 18 to 35 percent clay,

TABLE A-4. WATER RECLAMATION PLANT: INFLUENT AND EFFLUENT WATER QUALITY (1975)[a]

Month or Item	Flow Rate (10^3 cu m)		Effluent Use (%)		BOD_5		
	Total	Daily Avg.	Irrigation	Creek Discharge	Influent (mg/liter)	Effluent (mg/liter)	Removal (%)
January	320.7	10.3	50	50	236	10.7	95
February	292.6	10.5	0.2	99.8	224	13.4	94
March	316.5	10.2	0	100	206	9.8	95
April	309.4	10.3	26	74	233	6.9	97
May	312.0	10.1	100	0	206	10.2	95
June	309.5	10.3	100	0	203	9.4	95
July	320.3	10.3	100	0	184	8.7	95
August	317.5	10.3	88	12	187	10.5	94
September	318.5	10.6	70	30	182	7.7	96
October	316.5	10.2	100	0	185	8.2	96
November	321.7	10.7	80	20	196	7.5	96
December	334.2	10.8	93	7	212	8.3	96
Total	3,788.5	NA[b]	NA[c]	NA	NA	NA	NA
Average	315.8	10.4	67	33	205	9.3	95

Month or Item	Suspended Solids			Settleable Solids		
	Influent (mg/liter)	Effluent (mg/liter)	Removal (%)	Influent (mg/liter)	Effluent (mg/liter)	Removal (%)
January	252	7.3	97	16	<0.1	99
February	263	4.8	98	11.2	<0.1	99
March	240	5.8	98	12	<0.1	99
April	285	6.2	98	10	<0.1	99
May	250	7.1	97	10	<0.1	99
June	231	8.8	96	11.5	<0.1	99
July	218	9.0	96	12	<0.1	99
August	237	11.5	95	8	<0.1	99
September	228	9.3	96	11	<0.1	99
October	204	8.4	96	10	<0.1	99
November	233	8.4	96	11	<0.1	99
December	226	8.9	96	11	<0.1	99
Total	NA	NA	NA	NA	NA	NA
Average	239	8.0	97	11.1	<0.1	99

(continued)

TABLE A-4. (continued)

Month or Item	Temperature (°C)	TDS (mg/liter)	Chloride (mg/liter)	Boron (mg/liter)	Turbidity (JTU)	Fecal Coliform (MPN/ 100 ml)	Total Coliform (MPN/ 100 ml)
January	17.4	--	—	--	4.3	—	< 2
February	17.7	900	147	0.28	3.3	< 2	< 2
March	16.7	874	149	0.07	2.0	< 2	< 2
April	18.9	870	152	0.69	2.3	< 2	< 2
May	22.7	849	153	0.52	4.9	< 2	< 2
June	24.0	840	147	0.95	5.4	< 2	< 2
July	24.7	812	153	0.95	6.0	< 2	< 2
August	26.3	840	152	0.97	3.9	< 2	< 2
September	25.3	770	145	1.00	2.8	< 2	< 2
October	22.8	828	139	0.80	1.5	< 2	< 2
November	20.8	803	137	0.85	2.1	< 2	< 2
December	16.0	816	147	0.82	2.1	< 2	< 2
Total	NA	NA	NA	NA	NA	NA	NA
Average	21.1	837	147	0.72	3.4	< 2	< 2

Month or Item	p^H	Dissolved Oxygen (mg/liter)	Cl_2 Added (kg)	Cl_2 Residual		SO_4 (mg/liter)	Oil and Grease (mg/liter)
				(kg)	(mg/liter)		
January	7.2	4.1	1,641	2.17	<0.01	--	--
February	7.0	3.7	1,768	2.45	<0.01	--	4.6
March	7.1	5.3	1,645	2.36	<0.01	199	1.5
April	7.3	3.1	1,699	2.09	<0.01	219	1.8
May	7.3	4.6	1,947	2.09	<0.01	287	3.2
June	7.1	3.5	1,963	2.13	<0.01	236	1.2
July	7.4	4.1	2,016	1.72	<0.01	182	1.6
August	7.5	3.8	2,181	2.31	<0.01	193	3.0
September	7.5	4.2	2,015	2.72	<0.01	211	1.8
October	7.5	3.0	2,208	2.40	<0.01	215	2.4
November	7.5	4.9	2,248	3.18	<0.01	233	1.5
December	7.5	3.1	2,241	2.68	<0.01	200	2.0
Total	NA	NA	23,572	NA	NA	NA	NA
Average	7.3	4.0	1,965	2.36	<0.01	218	2.2

(continued)

TABLE A-4. (continued)

Month or Item	Fluoride (mg/liter)	MBAS (mg/liter)	Nitrogen (mg/liter)			
			NO_2	NO_3	NH_3	Organic
January	--	--	--	--	--	--
February	0.89	0.2	0.3	3.0	8	<1
March	0.87	0.1	0.7	5.9	17	4
April	0.88	0.1	0.3	1.1	16	<1
May	0.50	0.1	0.5	1.7	11	3
June	0.50	0.1	0.4	1.9	12	1
July	0.50	0.1	0.5	1.2	12	4
August	0.50	0.2	0.7	0.4	11	3
September	0.50	0.1	1.0	2.2	11	1
October	0.40	0.2	0.2	1.9	16	1
November	0.60	0.2	0.2	0.7	13	4
December	1.10	0.2	0.6	1.3	15	3
Total	NA	NA	NA	NA	NA	NA
Average	0.66	0.1	0.5	1.9	13	2

Month or Item	Rainfall (cm)	Radioactivity (pc/liter)		Heavy Metals (mg/liter)				
		Alpha	Beta	Cd	Total Cr	Cu	Pb	Hg
January	0.00	--	--	--	--	--	--	--
February	5.84	4	23±	0.01	0.1	0.1	0.05	0.005
March	7.29	--	--	--	--	--	--	--
April	2.16	--	--	--	--	--	--	--
May	0.00	<8	7±	< 0.01	< 0.01	0.02	<0.05	0.002
June	0.00	--	--	--	--	--	--	--
July	0.00	--	--	--	--	--	--	--
August	0.00	0±4	28±2	< 0.01	< 0.01	< 0.1	<0.05	<0.002
September	0.00	--	--	--	--	--	--	--
October	0.64	--	--	--	--	--	--	--
November	0.00	0±3	36±2	< 0.01	< 0.01	< 0.03	<0.05	<0.002
December	0.00	--	--	--	--	--	--	--
Total	15.93	NA	NA	NA	NA	NA	NA	NA
Average	1.33	3±	24±	< 0.01	< 0.03	< 0.1	<0.05	<0.005

(continued)

TABLE A-4. (continued)

Month or Item	Heavy Metals (mg/liter) Ni	Ag	Zn	As	Se
January	—	—	—	—	—
February	< 0.1	0.1	0.1	0.05	0.05
March	—	—	—	—	—
April	—	—	—	—	—
May	< 0.2	<0.04	<0.1	<0.01	<0.05
June	—	—	—	—	—
July	—	—	—	—	—
August	< 0.1	<0.04	<0.1	<0.01	<0.01
September	—	—	—	—	—
October	—	—	—	—	—
November	< 0.2	<0.1	<0.5	<0.02	<0.01
December	—	—	—	—	—
Total	NA	NA	NA	NA	NA
Average	< 0.1	<0.07	<0.2	<0.02	<0.03

[a] Water quality data supplied by the Camarillo Sanitary District

[b] Not applicable.

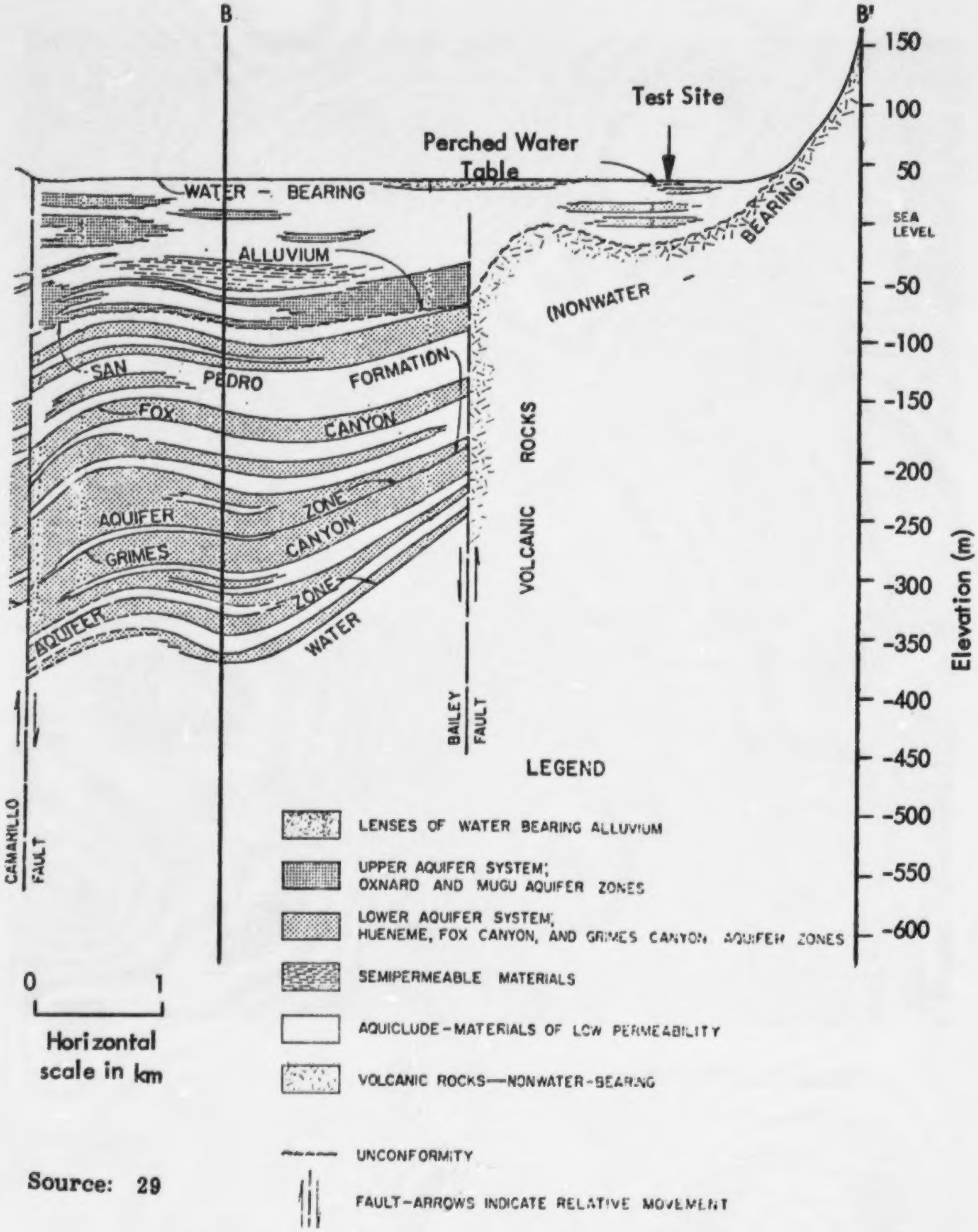
[c] Total quantity used for irrigation = 2,569.3 x 10^3 cu m.

TABLE A-5. WASTE DISCHARGE REQUIREMENTS FOR SURFACE DISPOSAL OF WATER RECLAMATION EFFLUENT

Parameter (All units mg/l, except as noted)	Discharge Point		
	Conejo Creek NPDES CA0053597 Effective 7/1/78	Surface Irrigation WCB Order 74-383	Spray Irrigation Title 22
BOD$_5$	20	20	20
Suspended Solids	15	15	15
Fecal Coliform (MPN/100 ml)	200	< 2.2	<2.2
Oil and Grease	10	--	- -
Settleable Solids (ml/l)	0.1	0.1	0.1
Turbidity (JTU)	10	10	10[a]
TDS	1000	1000	1000
Chloride	175	175	175
Chloride and Sulfate	500	500	500
Boron	1.0	1.0	1.0
Detergents (MBAS)	0.5	0.5	0.5
Residual Chlorine	0.1	--	--
Arsenic	0.01	0.10	0.10
Cadmium	0.01	0.01	0.01
Chromium (total)	0.005	0.05	0.05
Copper	0.2	--	--
Lead	0.05	0.05	0.05
Mercury	0.001	0.005	0.005
Nickel	0.1	--	--
Silver	0.02	--	--
Zinc	0.3	--	--
Cyanide	0.1	0.2	0.2
Selenium	0.01	0.01	0.01
Phenols	0.1	--	--
Nitrogen (total)	30	30	30
Chlorinated Hydrocarbons	0.002	--	--
Toxicity (TU)	1.5	--	--
Fluoride	1.2	1.2	1.2
pH (-log (H^+))	$6.5 < pH < 9.0$	$6.5 < pH < 9.0$	$6.5 < pH < 9.0$
T (°F)	<100	--	--

[a] Title 22 specifies that a filtered wastewater must not exceed an average turbidity of 2 JTU.

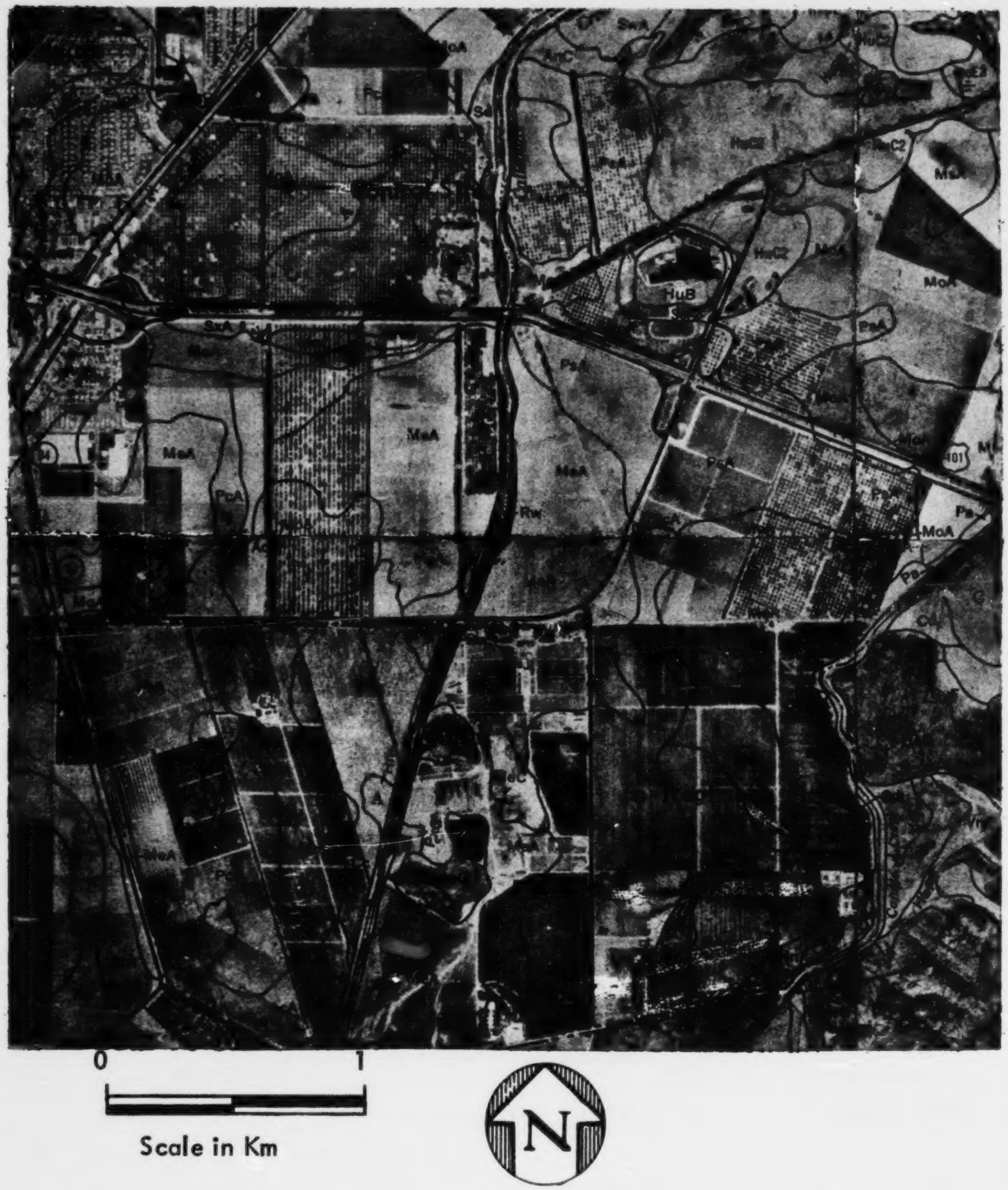
Source: 29.


B
B'
150
100
50
SEA LEVEL
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
-550
-600
Elevation (m)
Test Site
Perched Water Table
WATER - BEARING
ALLUVIUM
(NONWATER - BEARING)
SAN PEDRO FORMATION
FOX CANYON
AQUIFER ZONE
GRIMES CANYON
AQUIFER ZONE
WATER
VOLCANIC ROCKS
BAILEY FAULT
CAMARILLO FAULT
LEGEND
LENSES OF WATER BEARING ALLUVIUM
UPPER AQUIFER SYSTEM; OXNARD AND MUGU AQUIFER ZONES
LOWER AQUIFER SYSTEM; HUENEME, FOX CANYON, AND GRIMES CANYON AQUIFER ZONES
SEMIPERMEABLE MATERIALS
AQUICLUDE-MATERIALS OF LOW PERMEABILITY
VOLCANIC ROCKS—NONWATER-BEARING
UNCONFORMITY
FAULT-ARROWS INDICATE RELATIVE MOVEMENT
0
1
Horizontal scale in km

Source: 29

Figure A-4. Geological cross-section along B-B'. (See Figure A-2 for location of section)

Reproduced from best available copy.


MoA
ArC
SrA
HoC2
HuB
PsA
Rw
401
0
1
Scale in Km
N

Source: 30.

Figure A-5. Site soil map.

moderately alkaline and typically calcareous. Permeability is moderate and the surface runoff is slow with little erosion hazard.

Hambright very rocky loam (HaG) covers approximately 5 percent of the test site. This soil is characteristic of the mountainous uplands but covered and surrounded the large volcanic hill in the western part of the site. The surface layer is a brown, medium acidic and neutral clay loam and stony clay loam about 15 to 33 cm thick. Its permeability is moderate and surface runoff is rapid to very rapid, allowing severe erosion hazards.

Hueneme sandy loam (Hn) also covers approximately 5 percent of the site. This soil is found in the alluvial plain and is derived predominantly from weathered sedimentary rocks. The A horizon, 28 to 43 cm thick, varies from a light gray to dark brown and from light sandy loam to a loamy sand. It is mildly to moderately alkaline and calcareous soil. The lower horizon is about 109 to 124 cm thick and is also mildly to moderately alkaline and calcareous. The soil permeability is relatively good and surface runoff is very slow, resulting in little erosion hazard.

Site Hydrogeology

Alluvium overlies the Miocene volcanics. These essentially unconfined sand and gravel lenses and fractured volcanics are recharged through surface water infiltration from irrigation, precipitation, and stream inflow. Groundwater movement through the deeper volcanics is slow, due to the relative tightness of these rocks, while return flow seepage constitutes minor recharge to the lenses. Contours on the effective base of the groundwater reservoir indicate that the base declined towards the north and west. The Ventura County hydrologists are uncertain about groundwater movement directions, and stated that movement may possibly be either toward the north or west, or may follow the contours of the land toward the west and southwest. Groundwater movement can be hampered by the buried volcanic ridge to the west of the test site if the permeable lenses abut against the non-fractured volcanics and if the groundwater level lies below the level of the ridge.

The Bailey Fault, which is located approximately 1.2 to 1.6 km to the west of the test site, is most certainly a groundwater barrier. The inactive fault has not displaced the top alluvium and, hence, it may not affect the movement of the uppermost layer of groundwater 21 to 24 m below the ground level.

CONTROL SITE

General

The Camarillo control site is 19.6 hectares near U. S. Highway 101, approximately 2.8 km northwesterly of the test site; the location is shown in Figure A-1. Irrigation water is obtained from the city's potable distribution system. The farmer at times augments this supply from an on-site deep well.

Site Geology

The earth materials underlying the control site are representative of the main part of the Pleasant Valley basin. Approximately 90 m of topmost alluvium composed of silts and clays with sand and gravel lenses, overlie the San Pedro and Santa Barbara formations (Figure A-6). Included in these formations are the Fox Canyon and Grimes Canyon aquifer zones. The San Pedro and deeper formations do not have significant hydrologic continuity with the upper alluvial waters because the relatively impervious fines in the alluvium prevent infiltration of these upper groundwaters. This alluvium is thus commonly called a cap. The alluvial sands and gravel are essentially unconfined and are recharged by surface infiltration.

Soils

The two types of soils identified at the control site as shown in Figure A-5, are from the Mocho Series and Sorrento Series.

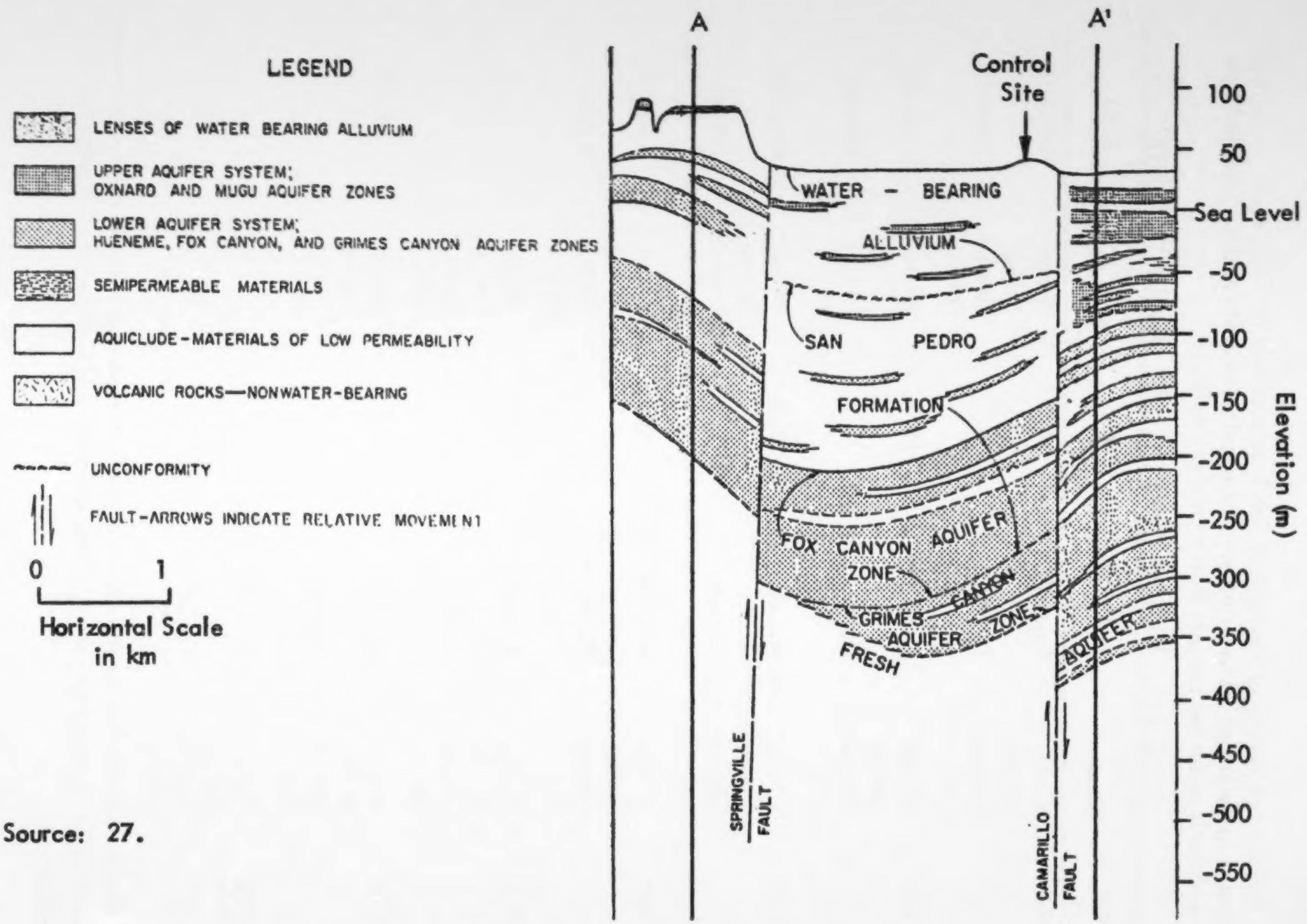
Mocho Loam (MoA) covers most of the site. It is formed on alluvial plains and fans, largely by decomposition of the sedimentary rocks. It is a grayish-brown, calcareous loam, 150 cm or more deep. It contains 18 to 35 percent clay, that is moderately alkaline and typically calcareous. The permeability is moderate and surface runoff is slow, resulting in little erosion hazard.

The Sorrento silty clay loam (S x A) covers approximately 15 percent of the site. It is formed on the alluvial fans and plains by alluvium which is also derived from the sedimentary rocks. The soil is grayish-brown and ranges from a neutral to mildly alkaline loam about 48 cm thick. Below this topsoil is a brown to light gray layer of moderately alkaline heavy loam that becomes calcareous between 61 and 109 cm. The total depth of the lower horizon is 152 cm or more. Permeability is moderately slow.

Hydrogeology

Studies of groundwater movement in the upper alluvial aquifers have not been completed. Local government agency hydrologists suggest that groundwater probably moves southward following the slope of the land topography.

The control site is located between the Springville fault and the Camarillo fault, and is separated from the test site by the Camarillo and Bailey faults (Figure A-2). The Camarillo fault is located approximately 91 m south of the control site. It displaces upper alluvium and is, therefore, considered to be active. Alluvial groundwater levels on the north and south sides of the fault are shown to be a barrier to groundwater movement, since the north side is perched. The control and test sites do not have hydrologic continuity.


LEGEND
LENSES OF WATER BEARING ALLUVIUM
UPPER AQUIFER SYSTEM; OXNARD AND MUGU AQUIFER ZONES
LOWER AQUIFER SYSTEM; HUENEME, FOX CANYON, AND GRIMES CANYON AQUIFER ZONES
SEMIPERMEABLE MATERIALS
AQUICLUDE-MATERIALS OF LOW PERMEABILITY
VOLCANIC ROCKS—NONWATER-BEARING
UNCONFORMITY
FAULT-ARROWS INDICATE RELATIVE MOVEMENT
0
1
Horizontal Scale in km
A
A'
Control Site
WATER - BEARING
ALLUVIUM
SAN PEDRO
FORMATION
FOX CANYON AQUIFER
ZONE
GRIMES CANYON
AQUIFER ZONE
FRESH AQUIFER
SPRINGVILLE FAULT
CAMARILLO FAULT
100
50
Sea Level
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
-550
Elevation (m)

Source: 27.

Figure A-6. Geological cross-section along A-A'.
(See Figure A-2 for location of section)

Agriculture

The agricultural history of the control site is summarized in Table A-6. Ninety percent of the crop irrigation water employing both sprinklers and furrows is derived from on-site wells, and about ten percent from municipal wells.

TABLE A-6. AGRICULTURAL HISTORY OF CONTROL SITE[a]

Year	Crop Season	Crop	Year	Crop Season	Crop
1966	Winter	Broccoli	1973	Winter	Broccoli
	Spring			Spring	
	Summer	Tomato		Summer	Tomato
	Fall			Fall	
1967	Winter	Broccoli	1974	Winter	Broccoli
	Spring			Spring	
	Summer	Tomato		Summer	Tomato
	Fall			Fall	
1968	Winter	Broccoli	1975	Winter	Broccoli
	Spring			Spring	
	Summer	Tomato		Summer	Tomato
	Fall			Fall	
1969	Winter	Broccoli	1976	Winter	Broccoli
	Spring			Spring	
	Summer	Tomato		Summer	Tomato
	Fall			Fall	
1970	Winter	Broccoli	1977	Winter	
	Spring			Spring	Spinach
	Summer	Tomato		Summer	
	Fall			Fall	
1971	Winter	Broccoli	1978	Winter	Broccoli
	Spring			Spring	
	Summer	Tomato			
	Fall				
1972	Winter	Broccoli			
	Spring				
	Summer	Tomato			
	Fall				

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[a] Information supplied by Farm Advisor, University of California, Cooperative Extension.

APPENDIX B

SAMPLE COLLECTION AND ANALYTICAL METHODS

SOIL SAMPLE COLLECTION METHOD

Soil samples were collected after the land was prepared (prior to planting) and after the final crop was harvested. Shallow soil samples were taken from the top 100 cm. The rationale was that because the soils were irrigated with wastewater for years, changes in soil strata would occur very slowly in the deeper strata in contrast to the shallower soil. In contrast, the uptake of the nutrients by the root zone of the crops within the first 100 cm could cause significant changes in the upper soil layer.

Collection Procedure

1) Soil samples were collected at both the test and control site locations which received the treated effluent or the regular irrigation water, respectively.

2) For shallow soils, each site was divided into 4 sectors. The center of each sector, if judged to be representative, was selected for sampling. Subsequent samples were taken at randomly selected points located on the perimeter of a circle with a radius of 150 cm and a center at the first sampling point. Samples were taken at locations where plants were particularly large, small, or malformed. No samples were taken at points where unusual plant size was due to an extreme abundance or scarcity of water, such as on the banks of irrigation ditches or at the edge of a field.

3) Three random locations were selected for deep soil sampling at each site. A 3 meter trench was then dug with a backhoe. Samples were taken at the desired depths from the walls of the trench using proper sterile techniques.

Depth of Sampling

1) Shallow soil samples were taken at the following depths: 0 to 2, 2 to 4, 9 to 11, 29 to 31, and 95-105 cm.

2) Deep soil samples were collected at depths of 195 to 205 cm and 295 to 305 cm.

Sample Treatment

1) Samples for microbiological examination were placed in previously sterilized test tubes. Additional soil was placed into Whirl-Pak bags.

2) Immediately after collecting each sample, the sample containers were marked with pertinent data; including date, location, depth, and site taken.

3) The soil samples were refrigerated in an ice chest containing dry ice while on location.

4) A field activities log (see Table B-1) was filled out at the time of sampling and sent with the samples.

BI-WEEKLY WATER QUALITY SAMPLING PROGRAM

Samples of the irrigation water, the groundwater from the wells, and the leachate from the lysimeters were collected for analyses every two weeks. Two-week composites of the treatment plant effluents were collected by the plant operators. Prior to collection, three bottles were prepared for preservation. For each sample, one bottle was acidified with nitric acid, another with sulfuric acid, and the third was autoclaved. Only one sterilized bottle was provided for each lysimeter sample because of the limited volume of leachate which could be collected. After collecting the sample, each bottle was properly labeled to describe their date, location, depth (if appropriate), and type of preservation. For each sample or group of samples, a field sample report (see Table B-2) was completed and accompanied the shipment of samples to the laboratory. After collection and while in transit, the samples were stored in an ice chest containing dry ice. Upon arrival to the laboratory, the samples were refrigerated at 4° C until analyzed. Specific sampling methods for each type of sample are described below.

Treatment Plant Effluent

1) The treatment plant operator composited a daily sample of secondary effluent over a two-week period. The sample was refrigerated at 4° C during this period of time.

2) The sample was picked up on the same day that the other samples were collected for shipment.

Control Site Irrigation Water Samples

Control site irrigation water samples, at Camarillo, were collected from the water lines which fed the irrigation systems.

TABLE B-1

FIELD ACTIVITIES LOG

Job No. ____

Collection of Soil Samples for Agronomical Purposes

Shallow & Deep Soil Sample Collection

Please answer in listed units of measure, if possible; if other units are used, specify them. Return completed forms to:

Ralph Stone and Company, Inc.
10954 Santa Monica Boulevard
Los Angeles, California 90025
(213) 478-1501 and 879-1115

1. Site Location: ____________________

____

____

( ) Test site; ( ) Control site (check one)

2. Observer: ____________________

3. Date of Observation: ____________ Time: ____________

4. Soil Description

a. Soil color: ____________________

b. Soil type: ( ) loam; ( ) silt; ( ) clay; ( ) sand; ( ) gravel; ( ) other ________

c. Soil moisture: ____________________

d. Soil odors: ____________________

e. Soil condition: ( ) hard pack; ( ) loose; ( ) other ____________

f. Soil surface condition: ____________________

g. Date of last soil tillage: ____________________

h. Date of last irrigation: ____________________

5. Depth to Groundwater Table: ____________________

6. Sample Collection
(Check off ( ) when collected.)

a. Section 1

	Subsamples									
Depth (cm)	1	2	3	4	5	6	7	8	9	10
0-2										
2-4										
9-11										
29-31										
95-105										
195-205										
295-305										

(continued)

TABLE B-1 (continued)

b. Section 2

					Subsamples					
Depth (cm)	1	2	3	4	5	6	7	8	9	10
0-2										
2-4										
9-11										
29-31										
95-105										
195-205										
295-305										

c. Section 3

Depth (cm)										
0-2										
2-4										
9-11										
29-31										
95-105										
195-205										
295-305										

7. Samples Mailed

Date	Time	Shipper

Please use space on reverse for additional comments.

Page 2 of 2

TABLE B-2
FIELD SAMPLE REPORT

Collection of Sample for Analytical Work

Return completed reports with samples to:

Ralph Stone and Company, Inc.
10954 Santa Monica Boulevard
Los Angeles, California 90025

Date: ______________ Time: ______________ Job No. ______________

Location: ____

Date Last Sample Taken: ____________________________________

Weather: ____

Sampler: ________________ Observer: ____________________

Sample Type: ___ wastewater; ___ irrigation water; ___ lysimeter; ___ deep well.

Source: ____

Volume: ________________ Odor: ________________

Color: ________________ Turbidity: ________________

Temperature: ________________ Bottle coded: ________________

Date shipped: ________________ Sample in shipment: ________________

Remarks: ____

____

____

____

Received by: ________________ Checked by: ________________

Delivered to lab ____________________________________

10/76

Leachate Collection from Lysimeters

1) The protective metal plate placed above the coiled lysimeter lines was located using a metal detector.

2) The metal plate and lysimeter lines were carefully uncovered using a shovel.

3) A sterilized sample bottle was connected to the proper lysimeter line and the sample was collected using a vacuum pump. (See Figure 4, Section 5).

4) After the sample was collected, the sample bottle was carefully detached from the vacuum line, and a sterilized bottle cap was quickly placed on the bottle.

Groundwater Sample Collection

1) A sample for bacteriological analysis from the top and bottom of the groundwater wells was taken first, using a test tube apparatus. The test tube apparatus consisted of a test tube covered by a cone-shaped aluminum foil. A tiny hole at the top of the cone provided an exit for air entrapped in the test tube while holes punched in the lower portion of the cone allowed the sample to enter the tube. A clean string was attached to the test tube to allow the collector to handle the apparatus without contamination. The whole apparatus was sterilized before use.

2) The string was tied to a rope and the test tube apparatus was lowered to the desired sampling depth. When the test tube was full, the apparatus was removed from the well, and the foil top replaced with a sterilized test tube cap.

3) The water level in the well was measured, using a steel tape, and then was recorded.

4) The water was then evacuated from the well with a submersible pump.

5) When the well had recovered to its previous level, water samples were taken from the top and bottom of the well. Two samples were taken from each depth; one was acidified with nitric acid, and the other was acidified with sulfuric acid.

COLLECTION OF PLANT TISSUES FOR ANALYTICAL WORK

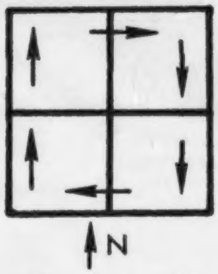
Tissue Sample Collection

1) Each site was divided into 4 sectors.

2) The sampler started at the center of the southwestern quarter and walked toward the north.

3) While walking, tissues were collected from four to six plants, according to crop and at 5 randomly selected locations. The fifth sample location was near the center of the northwestern section.

4) From this point, the sampler walked towards the east, taking samples of plant tissues as before. The sampler continued walking and taking random samples of plant tissues, completing the pattern shown in the adjacent diagram.



Time of Sampling

Samples were collected just before harvesting the crop to determine the quality of the crop as was used.

Tissue Sample Collection for Total and Fecal Coliform

1) Just before harvesting, two plants with entire root systems were dug up from 5 locations selected at random in each section.

2) The top portion of the plants were clipped and stored in Whirl-Pak bags.

3) The sterile bags were refrigerated in an ice chest, containing ice, while in transit to the laboratory.

4) Upon arrival to the laboratory, analyses of the samples were begun.

Sample Treatment

1) All the sample bags were identified as to date, location, type of crop, and any other pertinent data.

2) A field activities log (see Table B-3) was filled out at the time of sampling and shipped with the samples.

3) As stated above, all of the plant tissues were refrigerated in the field and were delivered to the laboratory in Los Angeles on the day of collection.

SOIL TESTING METHODS

Prior to planting, soil samples were collected and analyzed for bulk density, hydraulic conductivity, moisture content, organic content, particle density, and particle size distribution. The test methods used are listed in Table B-4. A field activities log was completed after the soil sample for bulk density was collected (see Table B-5).

TABLE B-3

FIELD ACTIVITIES LOG

Job No. ____

Collection of Plant Tissues for Analytical Work

Please return completed form to:

Ralph Stone and Company, Inc.
10954 Santa Monica Boulevard
Los Angeles, California 90025
(213) 478-1501 and 879-1115

1. Site Location: ______________________________
____
____

( ) Test site; ( ) Control site (check one)

2. Observer: ______________________________

3. Date of Observation: ____________; Time: ____________

4. Meteorological Information
(Obtain daily temperature and precipitation data from the nearest recording station. Make a log of system operation for at least a month prior to sampling.)

5. Crop Description

a. Crop name: ______________________________

b. Purpose: ______________________________

c. Crop sowing date: ______________________________

d. Crop height: ______________________________

e. Expected date of harvesting: ______________________________

6. Fertilizer Application

Name	Date	Quantity per acre

7. Pesticide, Fungicide, Insecticide Application

Name	Date	Concentration per acre

Please attach copies of available literature on the pesticides, etc., used.

Page 1 of 2

TABLE B-4 SOIL TESTS

Test	Method	Source (page number)
Bulk density	Core	375
Hydraulic conductivity	Constant head	214
Moisture content	Gravimetry, oven drying	92
Organic content	Volatilization, furnace	1,397
Particle density	Pycnometer	371
Particle size distribution	Hydometer	546

Source: 31 and 32.

TABLE B-5
FIELD ACTIVITIES LOG

Job No. ______

Determination of Bulk Density of Soil Using Core Method

Samples will be taken at beginning and end of study. Answer in listed units of measure, if possible; if other units are used, please specify them. Return completed forms to:

Ralph Stone and Company, Inc.
10954 Santa Monica Boulevard
Los Angeles, California 90025
(213) 478-1501 and 879-1115

1. Site Location: ______________________

( ) Test site; ( ) Control site (check one)

2. Observer: ______________________
3. Data of observation: ____________; Time: ____________
4. Soil Description
   a. Soil Color: ______________________
   b. Soil Type: ( ) loam; ( ) silt; ( ) clay; ( ) sand; ( ) gravel; ( ) other ____________
   c. Soil Moisture: ______________________
   d. Soil Odors: ______________________
   e. Soil Condition: ( ) hard pack; ( ) loose; ( ) other ____________
   f. Soil Surface Condition: ______________________
5. Depth to Groundwater Table (m): ______________________

Please make additional comments on reverse.

LABORATORY ANALYTICAL METHODS

Many aforementioned chemical and physical analyses were performed on the effluents from the Camarillosecondary treatment plants, the irrigation waters, the leachate from the lysimeters, the groundwaters, and the digested and extracted soil and crop samples. All the analyses performed, the methods used, and the references for the methods are shown in Tables B-6 and B-7 and in priorly noted tables.

QUALITY ASSURANCE PROGRAM

An on-going quality assurance program has been maintained by Stone to assure the precision and accuracy of the data resulting from the laboratory analyses. Guidelines established by the Analytical Quality Control Laboratory of the United States Environmental Protection Agency have been followed. These included the following:

1) Water samples for chemical analysis were collected according to the American Public Health Association recommended procedures (33), and preserved by nitric acid or sulfuric acid acidification, and refrigerated at 4°C.

2) Samples were labelled by priority at the time of collection and logged when they were received in the laboratory. Physical conditions at the time of sampling were documented.

3) All laboratory personnel complied with minimum educational requirements and were thoroughly trained in the tests which were assigned to them.

4) Records were kept of all activities in the laboratory. The laboratory work sheets were permanently stored in an indexed binder. The analytical information for reagent preparation, standardizations, etc., were recorded. Instrumental variables, such as the temperatures of the ovens and incubators, or spectrophotometer settings were calibrated against known standards and recorded at the time of testing on a daily basis.

5) Reagent grade chemicals and doubly treated deionized and/or distilled water were used.

6) All reagents and standard solutions were properly labelled and stored.

7) All standards and reagents were replaced on a fixed schedule according to their allowable shelf life and use periods.

8) Conductivity measurements of distilled and deionized water were taken periodically to assure their quality.

9) Instruments were routinely calibrated and maintained according to manufacturers' recommended schedules, or more frequently.

TABLE B-6. SOIL AND CROP PREPARATORY METHODS

Method	Comment	Reference[a] (page number)
Cation exchange capacity	Sodium saturation	899
Exchangeable cations	The decant, diluted to 250 ml in a volumetric flask, was analyzed for potassium, calcium, and magnesium	899
Extraction, water	Soil-to-water ratio of 1:10. Analysis was performed on sample ground with mortar and pestle to pass a 100-mesh sieve	9[b], 935
Extraction, acid	Same as water extraction, except 0.1 N hydrochloric acid was substituted for distilled water.	935
Total digestion	Wet digestion with perchloric-nitric acid and hydrofluoric acid	11[b]

[a] Source: 13.
[b] Source: 15.

TABLE B-7. ANALYTICAL METHODS

Test	Type Water	Soil	Crop	Importance	Rationale	Method	Reference (page number)
Metal							
Arsenic	X	X			May tend to biomagnify	Atomic absorption (gaseous hydride)	95
Barium	X	X	X			Atomic absorption	97
Cadmium	X	X	X	Minor	May tend to biomagnify	Atomic absorption	101
Calcium	X	X	X		Nutrient	Flame emission	103
Chromium	X	X	X			Atomic absorption	105
Copper	X	X	X	Minor	Phytotoxin	Atomic absorption	108
Lead	X	X	X			Atomic absorption	112
Magnesium	X	X	X	Minor	Nutrient, vital to photosynthesis	Atomic absorption	114
Manganese		X	X			Atomic absorption	116
Mercury		X				Cold vapor technique	118
Molybdenum	X	X	X	Minor	May tend to biomagnify	Atomic absorption	139
Nickel	X	X				Atomic absorption	141
Potassium	X	X	X	Minor	May affect plant growth	Atomic absorption	143
Selenium	X	X	X	Minor	Phototoxin, may biomagnify	Atomic absorption (gaseous hydride)	145
Silver		X				Atomic absorption	146
Sodium	X	X	X	Major		Flame emission	147
Zinc	X	X	X			Atomic absorption	155
Physical							
Total dissolved solids	X					Gravimetric	267
Specific conductance[a]	X			Major	Salinity has major impact on plant response	Electrometric	275

(continued)

TABLE B-7 (continued)

Test	Type			Importance	Rationale	Method	Reference (page number)[d]
	Water[a]	Soil[b]	Crop[c]				
Inorganic							
Boron	X	X	X	Major	Phytotoxin	Colorimetric (Curoumin)	13
Chloride	X	X	X	Major	Salinity has major impact on plant response	Titrimetric (Mercuric nitrate)	29
Fluoride	X	X		Minor	May tend to biomagnify	Colorimetric (SPADNS)	59
Nitrogen							
Total Kjeldahl	X	X			Nutrient	Digestion	175
Nitrate	X	X				Colorimetric (Brucine)	197
pH		X				Electrometric	239
Phosphorous					Nutrient		
Total		X	X			Colorimetric (Ascorbic acid)	481[e]
Phosphate	X	X				Colorimetric (Ascorbic acid)	481[e]
Organic phosphate		X				Colorimetric (Stannous chloride)	1038[f]
Sulfate	X		X			Turbidimetric	277
Organic							
Total organic carbon	X					Combustion	236
Microbiology							
Coliform				Major			
Total	X	X	X			Multiple tube fermentation	916[e]
Fecal	X	X	X			Multiple tube fermentation	922[e]
Nematodes		X				Baermann funnel technique	1517[f]
Protozoa		X				Singh method	1513[f]

(continued)

TABLE B-7 (continued)

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[a] Water: includes treatment plant effluent, irrigation water, lysimeter leachate, and groundwater.

[b] Soil: includes analyses of soils which were digested, acid and water extracted, and exchanged

[c] Crops: includes digestion and water extraction of leaves and fruit.

[d] Source: 35 unless otherwise noted.

[e] Source: 33

[f] Source: 32

10) Standard procedures (33,35)or other literature sources approved by the United States Environmental Protection Agency, were used. Supervisory personnel provided assurance that the established procedures were strictly followed.

11) A minimum of 10 percent of the samples were duplicated, or were spiked with known amounts of standards.

12) Intermittently, special samples such as distilled water were supplied as routine field collected samples; the laboratory staff knew of this field staff practice. Control charts, based on duplicate and spiked sample results, were used daily to maintain a high quality of work. Samples were re-run if the results of the duplicates and/or spikes were out of the established control ranges.

13) All analytical results were checked by laboratory supervisors and approved by company management.

APPENDIX C

WELL LOG AND SCHEMATIC DESIGN OF TEST WELLS

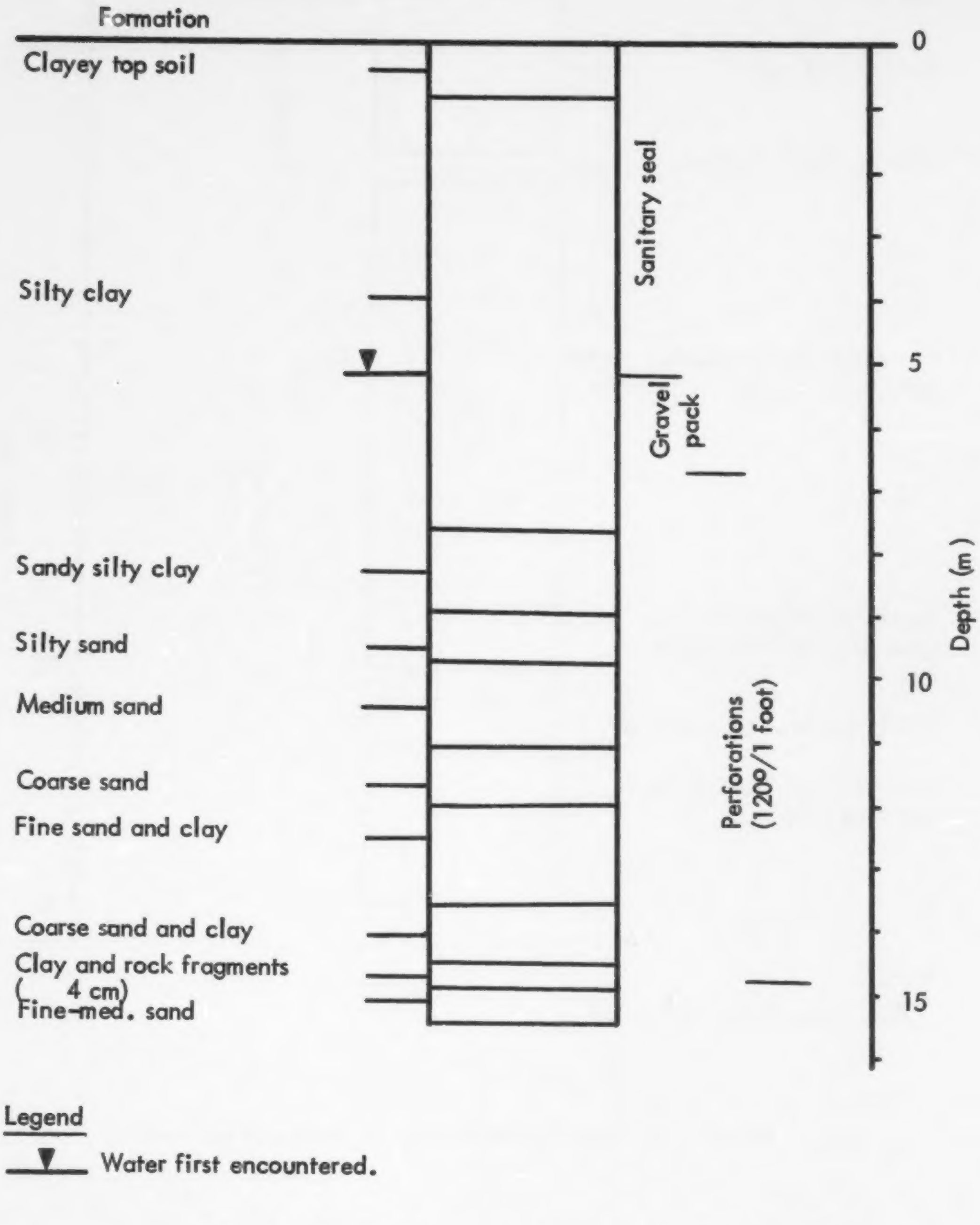
Formation
Clayey top soil
Silty clay
Sandy silty clay
Silty sand
Medium sand
Coarse sand
Fine sand and clay
Coarse sand and clay
Clay and rock fragments (4 cm)
Fine-med. sand
Sanitary seal
Gravel pack
Perforations (120°/1 foot)
Depth (m)
0
5
10
15
Legend
Water first encountered.

Figure C-1. Well log and schematic design of test well 1.

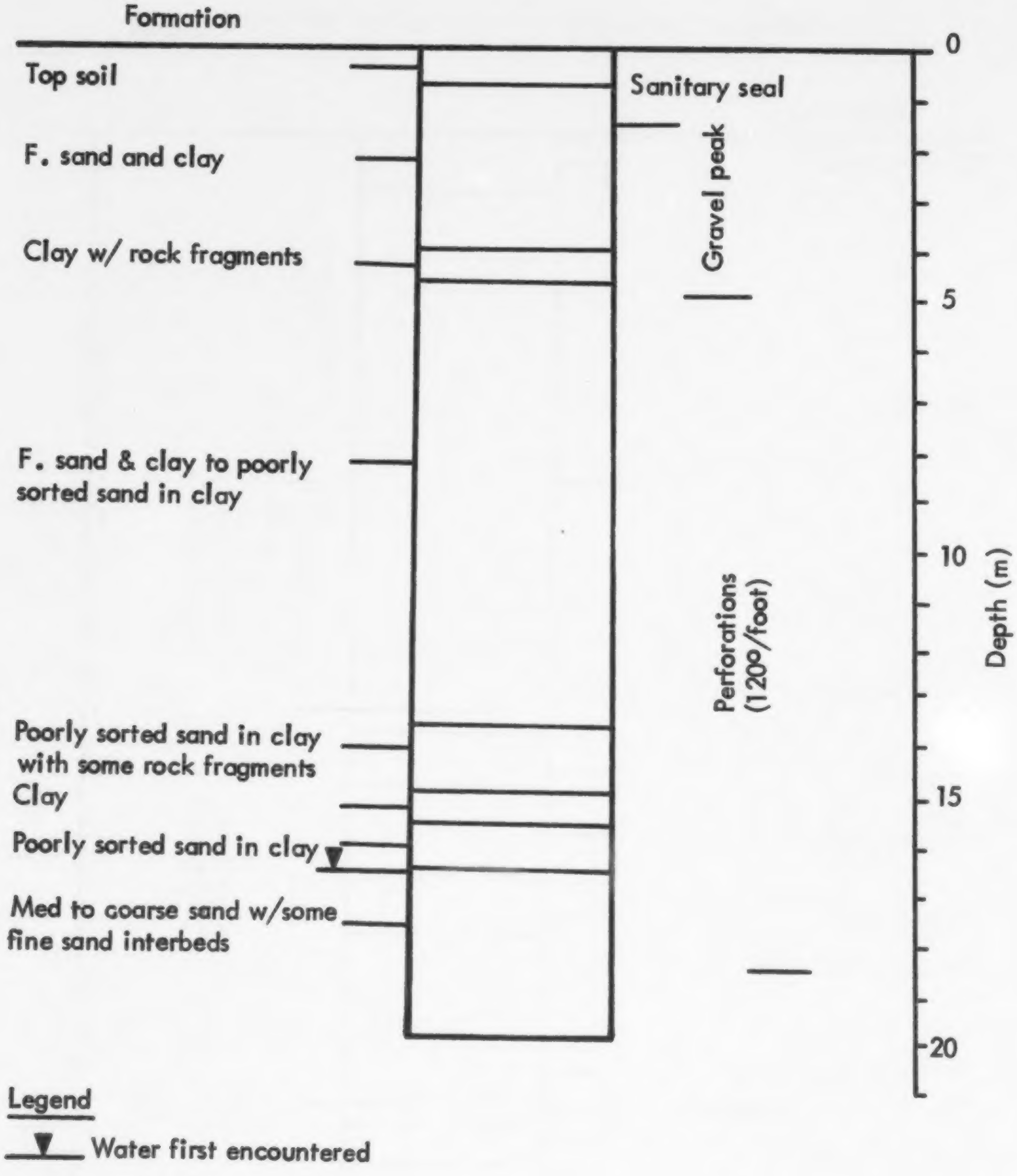
Formation
Top soil
F. sand and clay
Clay w/ rock fragments
F. sand & clay to poorly sorted sand in clay
Poorly sorted sand in clay with some rock fragments
Clay
Poorly sorted sand in clay
Med to coarse sand w/some fine sand interbeds
Sanitary seal
Gravel peak
Perforations (120°/foot)
Depth (m)
0
5
10
15
20
Legend
Water first encountered

Figure C-2. Well log and schematic design of test well 2.

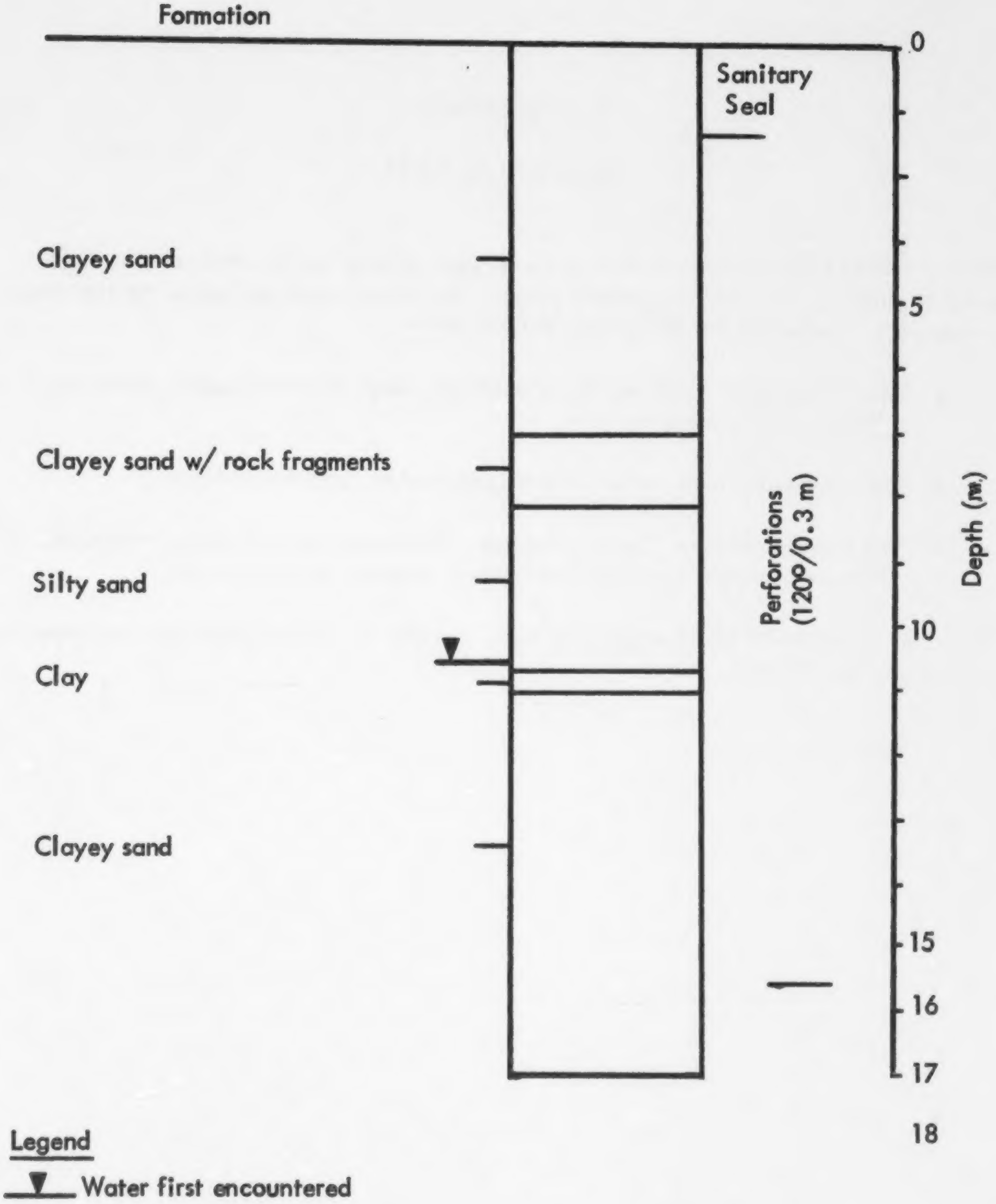
Formation
Sanitary Seal
Clayey sand
Clayey sand w/ rock fragments
Silty sand
Clay
Clayey sand
Perforations (120°/0.3 m)
Depth (m)
0
5
10
15
16
17
18
Legend
Water first encountered

Figure C-3. Well log and schematic design of test well 3.

APPENDIX D

ANALYTICAL DATA

All the values listed in Figures D-1 to D-13 were printed to two decimal places in order to simplify the computer programming. The actual reported values for the constituents were carried to the following decimal places.

- Whole numbers: total and fecal coliform, total dissolved solids, chloride, sulfates, sodium, and calcium.
- One decimal place: total nitrogen, potassium, and molybdenum.
- Two decimal places: boron, fluoride, nitrate-nitrogen, barium, cadmium, chromium, copper, nickel, lead, zinc, arsenic, and selenium.

The other constituents (total organic carbon, phosphate, and magnesium) were reported to three significant fitures.

TABLE D-1. ANALYTICAL RESULTS: TEST EFFLUENT

	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
10/14/76	NES	NES	NES	0.80	162.00	2.90	NES	NES	NES	NES	182.00	8.90	231.00
10/21/76	NES	NES	NES	0.72	193.70	1.50	NES	NES	NES	NES	106.00	11.60	353.00
11/ 7/76	1.25E+06	0.00	NES	0.87	161.40	1.86	NES	NES	NES	NES	166.00	20.10	NES
11/21/76	NES	NES	NES	0.27	185.90	NES	NES	NES	NES	NES	161.00	12.20	NES
12/ 7/76	NES	NES	NES	0.14	166.00	NES	NES	NES	NES	NES	NES	21.00	315.00
12/21/76	250.00	0.00	NES	1.08	125.00	1.93	NES	NES	NES	15.60	110.00	12.40	365.00
1/ 1/77	NES	NES	NES	1.09	123.00	1.88	NES	NES	NES	14.10	130.00	24.00	NES
1/21/77	2500.00	0.00	NES	0.44	NES	NES	NES	NES	NES	NES	NES	18.60	NES
2/14/77	NES	NES	900.00	1.15	129.00	0.78	NES	NES	NES	11.40	220.00	17.50	170.50
3/ 1/77	NES	NES	980.00	1.19	130.15	1.72	NES	NES	19.00	11.00	250.00	21.40	172.55
3/14/77	800.00	0.00	842.00	0.85	160.00	NES	13.80	NES	NES	NES	168.00	17.70	195.00
4/ 1/77	NES	NES	NES	0.72	NES	1.15	1.10	NES	NES	12.50	NES	21.00	409.50
4/14/77	79000.00	20.00	NES	1.39	183.00	NES	5.80	5.80	NES	16.40	NES	16.50	147.40
5/ 1/77	9200.00	50.00	1240.00	0.64	182.00	1.01	0.73	NES	25.00	14.00	220.00	21.00	200.00
5/ 7/77	24000.00	90.00	1250.00	1.53	179.00	1.85	0.81	3.75	49.00	2.90	210.00	15.40	126.50
5/21/77	17000.00	3300.00	1020.00	0.19	199.00	c	c	c	c	5.40	c	18.60	c
6/ 7/77	70.00	0.00	966.00	0.92	237.00	1.02	3.10	6.20	39.00	13.70	130.00	15.10	130.90
6/21/77	330.00	0.00	892.00	c	c	c	c	c	c	NES	c	c	c
7/ 7/77	90.00	0.00	NES	0.29	151.00	1.71	8.00	25.80	39.00	13.20	194.00	13.50	129.00
7/21/77	1400.00	20.00	830.00	c	c	c	c	c	c	c	c	c	c
8/ 7/77	80.00	5.00	934.00	0.91	182.00	1.78	4.60	24.00	51.00	11.32	185.00	16.10	183.00
8/21/77	0.00	0.00	930.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	1100.00	0.00	928.00	1.26	213.00	NES	4.36	17.00	42.00	13.23	180.00	17.20	202.00
9/14/77	790.00	90.00	NES	c	c	c	c	c	c	c	c	c	c
10/ 1/77	50.00	0.00	972.00	1.06	170.00	1.96	8.20	16.20	39.00	11.00	222.00	16.40	155.00
10/ 7/77	70.00	0.00	836.00	c	c	c	c	c	c	c	c	c	c
10/21/77	35000.00	1700.00	1078.00	1.08	183.00	2.54	7.00	19.40	35.00	10.80	274.00	16.50	190.00
11/ 7/77	330.00	50.00	1270.00	c	c	c	c	c	c	c	c	c	c
11/21/77	330.00	0.00	900.00	0.75	196.60	1.09	1.10	14.60	18.00	11.80	255.00	15.90	200.00
12/ 7/77	790.00	220.00	1052.00	c	c	c	c	c	c	c	c	c	c
12/21/77	2800.00	0.00	900.00	0.97	179.00	0.95	4.50	NES	34.00	12.00	293.00	16.90	192.00
1/ 1/78	490.00	0.00	1096.00	c	c	c	c	c	c	c	c	c	c
1/ 7/78	0.00	0.00	1088.00	1.05	1.90	1.20	1.75	17.60	26.00	12.30	227.00	17.10	171.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
10/14/76	125.00	20.90	0.05	0.00	0.00	0.02	NES	0.20	0.00	0.00	0.00	0.00
10/21/76	NES	20.60	0.01	0.00	0.04	0.07	NES	0.10	0.10	0.09	0.00	0.00
11/ 7/76	145.00	31.10	0.02	0.01	0.07	0.05	NES	0.00	0.00	0.05	0.00	0.00
11/21/76	122.00	29.80	0.03	0.03	0.07	0.03	NES	0.10	0.10	0.03	0.00	0.00
12/ 7/76	88.00	31.10	0.00	0.01	0.00	0.05	NES	0.40	0.03	0.05	0.00	0.00
12/21/76	90.00	19.90	0.08	0.02	0.05	0.04	0.10	0.20	0.05	0.00	0.02	0.01
1/ 1/77	104.00	20.50	0.01	0.01	0.02	0.03	0.10	0.11	0.00	0.06	0.00	0.00
1/21/77	114.00	23.50	0.04	0.04	0.00	0.09	NES	0.50	0.03	0.02	0.01	0.00
2/14/77	19.00	25.80	0.30	0.02	0.03	0.09	0.10	0.03	0.06	0.03	0.01	0.01
3/ 1/77	28.00	26.40	NES	0.03	0.01	0.04	0.10	0.03	NES	0.04	0.01	0.01
3/14/77	NES	41.00	NES	0.03	0.01	0.08	NES	NES	0.02	0.02	NES	NES
4/ 1/77	23.00	NES	0.10	0.00	0.02	0.13	0.10	0.11	0.00	0.01	NES	NES
4/14/77	20.00	26.40	0.10	0.02	0.02	0.07	0.20	0.06	0.02	0.08	0.01	0.01
5/ 1/77	56.00	75.00	0.10	0.00	0.00	0.03	0.10	0.03	0.10	0.03	0.01	0.01
5/ 7/77	28.00	26.40	0.02	0.02	0.07	0.06	0.10	0.02	0.07	0.07	0.01	0.10
5/21/77	c	19.58	c	0.01	c	c	c	c	0.06	0.11	c	c
6/ 7/77	27.00	28.30	0.10	0.02	0.01	0.02	0.10	0.07	NES	0.08	0.01	0.01
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	22.00	14.85	0.10	0.02	0.01	0.07	0.10	0.05	0.04	0.05	0.03	0.01
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	NES	44.60	0.03	0.02	0.02	0.03	0.10	0.12	0.10	0.08	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	20.00	35.20	0.08	0.02	0.02	0.05	0.10	0.02	0.05	0.05	0.01	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	22.00	69.70	0.02	0.02	0.02	0.08	0.10	0.02	0.08	0 06	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	26.00	48.00	0.10	0.02	0.01	0.08	0.10	0.03	0.03	0.05	0.01	0.01
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
11/21/77	24.00	40.00	0.19	0.01	0.01	0.06	0.10	0.03	0.06	0.06	0.01	0.01
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	25.00	53.00	0.05	0.01	0.02	0.08	0.10	0.03	0.07	0.06	0.01	0.01
1/ 1/78	c	c	c	c	c	c	c	c	c	c	c	c
1/ 7/78	23.00	38.00	0.15	0.01	0.01	0.03	0.10	0.02	0.07	0.06	0.01	0.01

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TABLE D-2. ANALYTICAL RESULTS: CONTROL IRRIGATION

ATION	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
3/21/77	NES	NES	NES	0.29	NES	0.30	3.10	NES	NES	1.16	NES	6.20	110.00
5/14/77	0.00	0.00	NES	0.21	71.00	0.29	0.50	0.50	4.50	0.28	240.00	3.90	89.00
5/21/77	0.00	0.00	780.00	0.20	70.70	c	c	c	c	0.30	c	4.10	c
6/ 7/77	0.00	0.00	812.00	0.34	89.00	0.20	1.77	2.00	3.00	0.90	210.00	4.00	88.00
6/21/77	0.00	0.00	NES	0.25	76.00	0.80	4.00	13.00	9.00	1.19	210.00	6.60	66.00
7/21/77	0.00	0.00	682.00	c	c	c	c	c	c	c	c	c	c
8/ 7/77	0.00	0.00	676.00	0.16	70.00	0.77	0.70	0.70	5.00	0.45	200.00	4.00	85.00
8/21/77	0.00	0.00	690.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	0.00	0.00	664.00	0.18	62.00	0.90	0.50	0.50	4.00	0.12	222.00	4.20	68.00
9/14/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
10/ 1/77	0.00	0.00	894.00	0.30	83.00	0.84	8.20	8.20	3.00	0.10	218.00	3.60	162.00
10/ 7/77	0.00	0.00	590.00	c	c	c	c	c	c	c	c	c	c
10/21/77	0.00	0.00	662.00	0.16	57.00	0.76	3.10	6.60	7.50	0.10	274.00	4.20	77.00
11/ 7/77	0.00	0.00	970.00	c	c	c	c	c	c	c	c	c	c
11/21/77	0.00	0.00	520.00	0.30	76.60	0.92	0.10	0.10	0.50	0.10	200.00	4.50	73.00
12/ 7/77	0.00	0.00	706.00	c	c	c	c	c	c	c	c	c	c
12/21/77	0.00	0.00	632.00	0.26	53.00	0.45	0.80	1.60	0.50	0.10	234.00	4.50	66.00
1/ 7/78	0.00	0.00	842.00	c	c	c	c	c	c	c	c	c	c
1/21/78	0.00	0.00	670.00	0.13	94.00	0.45	0.30	1.30	0.50	0.80	258.00	5.40	86.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
12/ 7/76	NES	20.40	0.20	NES	0.01	0.05	0.10	NES	0.04	0.04	NES	0.01
3/21/77	NES	NES	0.60	0.00	0.06	0.12	0.10	0.10	0.30	0.03	NES	NES
5/14/77	63.00	20.46	0.10	0.01	0.02	0.20	0.10	0.10	0.05	0.07	0.01	0.01
5/21/77	c	19.80	c	0.01	c	c	0.10	c	0.05	c	c	c
6/ 7/77	55.00	28.90	0.20	0.02	0.03	0.14	0.10	0.07	NES	0.07	0.01	0.01
6/21/77	56.00	26.30	0.40	0.03	0.06	0.10	0.10	0.02	0.11	0.03	0.04	NES
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	38.00	61.60	0.07	0.01	0.02	0.13	0.10	0.05	0.04	0.06	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	48.00	46.20	0.09	0.02	0.02	0.17	0.10	0.02	0.09	0.09	0.01	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	39.90	67.70	0.07	0.02	0.02	0.15	0.10	0.01	0.03	0.11	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	52.00	53.00	0.03	0.01	0.01	0.17	0.10	0.02	0.03	0.07	0.01	0.01
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
11/21/77	41.00	35.00	0.06	0.01	0.01	0.03	0.10	0.03	0.03	0.05	0.01	0.01
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	55.00	58.00	0.06	0.01	0.04	0.20	0.06	0.05	0.06	0.16	0.01	0.01
1/ 7/78	c	c	c	c	c	c	c	c	c	c	c	c
1/21/78	46.00	44.00	0.10	0.01	0.01	0.07	0.10	0.03	0.07	0.07	0.01	0.01

TABLE D-3. ANALYTICAL RESULTS: TEST LYSIMETER, 50 CM

	* MPN/100 ml *					Constituent(mg/l)							
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
1/21/77	0.00	0.00	NES	0.78	NES	NES	NES	NES	18.80	NES	NES	NES	NES
2/ 1/77	0.00	0.00	2600.00	0.88	NES	NES	23.00	NES	NES	NES	NES	NES	NES
3/21/77	NES	NES	NES	1.32	NES	NES	NES	NES	NES	NES	NES	18.00	310.00
4/ 1/77	NES	NES	NES	0.16	NES	0.36	NES	NES	NES	NES	NES	30.00	365.00
4/14/77	0.00	0.00	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
4/21/77	780.00	20.00	NES	c	c	c	c	c	c	c	c	c	c
5/ 1/77	0.00	0.00	NES	0.58	320.00	0.70	NES	NES	25.00	NES	210.00	40.00	380.00
5/14/77	0.00	0.00	NES	0.51	299.00	1.47	NES	NES	34.00	3.50	316.00	28.00	297.00
5/21/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
6/ 7/77	0.00	0.00	2758.00	1.36	230.00	0.28	61.20	65.00	23.00	3.86	349.00	20.90	155.00
6/21/77	0.00	0.00	1582.00	c	c	c	c	c	c	c	c	c	c
7/ 7/77	0.00	0.00	2290.00	0.30	196.00	0.93	NES	NES	62.00	5.61	217.00	40.60	146.00
7/21/77	0.00	0.00	1418.00	c	c	c	c	c	c	c	c	c	c
8/ 7/77	0.00	0.00	1784.00	1.17	206.00	0.73	42.90	NES	42.00	4.04	215.00	33.50	130.00
8/21/77	0.00	0.00	1410.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	0.00	0.00	1328.00	NES	246.00	1.41	26.10	27.20	38.00	NES	264.00	32.20	245.00
9/14/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
10/ 1/77	50.00	0.00	1906.00	1.78	359.00	0.80	13.00	15.40	15.40	2.30	389.00	23.30	235.00
10/ 7/77	0.00	0.00	1866.00	c	c	c	c	c	c	c	c	c	c
10/21/77	70.00	0.00	NES	NES	NES	NES	NES	NES	NES	NES	NES	21.40	315.00
11/ 7/77	0.00	0.00	1400.00	c	c	c	c	c	c	c	c	c	c
11/21/77	0.00	0.00	1182.00	0.90	211.00	0.67	29.70	29.70	4.00	3.60	242.00	20.10	177.00
12/ 7/77	0.00	0.00	1384.00	c	c	c	c	c	c	c	c	c	c
12/21/77	NES	NES	NES	1.16	183.00	0.33	44.00	44.60	13.50	3.70	242.00	20.00	201.00
1/ 7/78	20.00	0.00	1612.00	c	c	c	c	c	c	c	c	c	c
1/21/78	NES	NES	1594.00	0.70	215.00	0.61	36.50	37.50	11.50	11.60	227.00	21.30	250.00

					Constituent(mg/l)							
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
1/21/77	NES	NES	0.05	0.03	0.18	0.34	0.10	0.22	0.20	NES	NES	0.00
2/ 1/77	NES	NES	0.05	0.03	0.17	0.03	0.10	0.16	0.20	0.35	NES	0.00
3/21/77	160.00	240.00	0.20	NES	NES	0.15	0.10	NES	NES	NES	NES	NES
4/ 1/77	NES	NES	NES	0.02	0.08	NES	NES	0.29	0.20	0.27	NES	NES
4/21/77	c	c	c	c	c	c	c	c	c	c	c	c
5/ 1/77	310.00	NES	0.70	0.02	0.03	0.49	0.10	0.16	0.29	1.22	NES	0.01
5/14/77	212.00	69.00	0.10	0.01	0.07	0.09	0.10	NES	0.06	0.09	NES	0.01
5/21/77	c	c	c	c	c	c	c	c	c	c	c	c
6/ 7/77	153.00	56.00	0.10	0.01	0.03	0.44	NES	0.13	0.15	1.09	0.01	0.01
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	116.00	64.00	0.10	0.03	0.03	0.20	0.10	0.08	0.18	0.60	0.02	0.01
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	42.00	106.00	NES	0.01	0.03	0.39	NES	0.07	0.06	0.55	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	57.00	700.00	0.26	0.02	0.02	0.15	0.10	0.03	0.04	0.19	0.02	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	67.60	107.00	0.12	0.02	0.02	0.11	0.10	0.02	0.04	0.27	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	65.00	160.00	0.35	0.01	0.01	0.03	0.10	0.05	0.03	0.06	NES	NES
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
11/21/77	33.00	42.00	0.14	0.01	0.01	0.07	0.10	0.04	0.02	0.37	0.01	0.01
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	54.00	88.00	0.10	0.01	0.04	0.11	0.10	0.05	0.08	0.18	0.01	0.01
1/ 7/78	c	c	c	c	c	c	c	c	c	c	c	c
1/21/78	80.00	75.00	0.21	0.01	0.01	0.05	0.30	0.03	0.09	0.12	0.01	0.01

TABLE D-4. ANALYTICAL RESULTS: CONTROL LYSIMETER, 50 CM

	* MPN/100 ml *						Constituent(mg/l)						
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
1/14/77	6.00	0.00	NES	0.63	NES	NES	NES	NES	NES	NES	220.00	23.00	NES
1/21/77	0.00	0.00	NES	1.02	131.00	NES	NES	NES	NES	3.45	390.00	NES	295.00
2/ 1/77	0.00	0.00	NES	0.62	115.00	NES	15.00	NES	NES	NES	270.00	15.50	136.00
4/ 7/77	0.00	0.00	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
4/21/77	0.00	0.00	NES	c	c	c	NES	c	c	c	c	c	c
5/ 1/77	0.00	0.00	NES	0.77	176.00	1.13	22.50	34.60	13.00	10.30	NES	20.00	220.00
5/14/77	0.00	0.00	NES	0.38	199.00	0.45	NES	NES	28.00	3.90	509.00	NES	210.00
5/21/77	0.00	0.00	NES	NES	NES	NES	NES	NES	NES	NES	NES	10.10	NES
6/ 7/77	0.00	0.00	NES	0.41	226.00	0.36	37.70	37.70	47.00	3.95	550.00	17.50	165.00
6/21/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
7/ 7/77	0.00	0.00	NES	NES	209.00	1.43	36.80	NES	39.00	5.50	407.00	28.80	133.00
7/21/77	0.00	0.00	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
8/21/77	0.00	0.00	1808.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	20.00	0.00	1780.00	1.40	235.00	1.48	5.00	5.60	NES	0.19	520.00	8.80	238.00
9/14/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
10/ 1/77	0.00	0.00	1936.00	1.11	226.00	1.40	21.00	22.10	20.00	1.78	452.00	10.50	212.00
10/21/77	0.00	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	14.70	235.00
11/ 7/77	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
11/21/77	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
12/21/77	50.00	0.00	2068.00	0.81	295.00	0.61	59.50	61.70	16.50	1.50	585.00	10.20	225.00
1/ 7/78	0.00	0.00	2390.00	c	c	c	c	c	c	c	c	c	c
1/21/78	NES	NES	NES	0.20	356.00	1.29	NES	3.15	NES	3.80	NES	9.90	320.00

					Constituent(mg/l)							
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
1/14/77	NES	27.60	0.02	0.06	0.02	0.06	0.40	0.07	0.07	NES	0.01	0.01
1/21/77	NES	NES	0.01	0.02	0.03	0.08	0.10	0.10	0.08	NES	0.01	0.01
2/ 1/77	NES	46.00	0.01	0.05	0.02	0.15	0.10	0.09	0.06	NES	0.01	0.07
3/21/77	NES	NES	NES	0.06	NES	NES	NES	NES	NES	NES	NES	NES
4/21/77	c	c	c	c	c	c	c	c	c	c	c	c
5/ 1/77	NES	NES	0.04	0.01	0.01	0.02	0.10	0.07	0.08	0.46	0.04	0.01
5/14/77	108.00	36.63	NES	0.01	0.01	0.11	0.10	c	0.08	0.62	c	0.01
6/ 7/77	107.00	63.30	NES	0.01	0.02	0.22	NES	0.10	0.06	0.68	NES	0.01
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	37.00	144.10	0.20	0.03	0.06	0.10	0.10	0.09	0.11	NES	0.04	0.01
7/21/77	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	75.00	151.00	0.20	0.02	0.02	0.16	0.10	0.03	0.02	0.42	0.03	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	88.40	190.00	0.12	0.02	0.02	0.20	0.10	0.03	0.05	0.21	0.01	0.01
10/21/77	6.60	190.00	0.21	NES	0.01	NES	0.10	0.05	0.10	0.23	NES	NES
11/ 7/77	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
12/21/77	124.00	282.00	0.11	0.01	0.04	0.15	0.10	0.07	0.06	0.30	0.01	0.01
1/ 7/78	c	c	c	c	c	c	c	c	c	c	c	c
1/21/78	205.00	140.00	0.21	0.01	0.01	0.06	0.10	0.03	0.10	0.54	0.01	0.01

TABLE D-5. ANALYTICAL RESULTS: TEST LYSIMETER, 100 CM

	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
1/21/77	6.00	0.00	2600.00	1.10	NES	NES	83.00	NES	15.90	0.30	NES	9.80	532.00
2/ 1/77	6.00	0.00	2200.00	1.27	NES	NES	NES	NES	15.00	0.51	NES	11.20	211.00
3/21/77	NES	NES	NES	0.93	NES	NES	NES	NES	NES	NES	NES	NES	NES
4/ 1/77	NES	NES	NES	0.27	NES	0.32	NES	NES	NES	NES	NES	22.00	460.00
4/14/77	0.00	0.00	NES	1.10	NES	NES	NES	NES	NES	NES	NES	19.00	NES
4/21/77	0.00	0.00	NES	c	NES	NES	c	c	c	c	c	c	NES
5/ 1/77	0.00	0.00	NES	0.68	173.00	0.60	63.00	NES	18.00	NES	230.00	11.00	235.00
5/14/77	3300.00	20.00	NES	0.36	115.00	0.80	39.90	NES	17 00	3.06	197.00	NES	139.00
5/21/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
6/ 7/77	0.00	0.00	NES	0.48	137.20	0.83	NES	37 20	24.00	3.60	200.00	19.20	125.40
6/21/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
7/ 7/77	0.00	0.00	NES	0.13	150.00	1.04	NES	NES	35 00	2.80	200.00	17.00	132 00
7/21/77	490.00	0.00	1572.00	c	c	c	c	c	c	c	c	c	c
8/ 7/77	0.00	0.00	1592.00	1.49	193.00	0.85	38.20	38.20	28.00	3.46	264.00	21.80	221.00
8/21/77	0.00	NES	2002.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	0.00	0.00	1500.00	NES	266.00	NES	57.50	NES	21.00	NES	264 00	17.70	255.00
10/ 1/77	50.00	0.00	1360.00	1.36	201.00	1.02	22.00	23.50	21.00	3.10	256.00	7.80	165.00
10/ 7/77	0.00	0.00	1574.00	c	c	c	c	c	c	c	c	c	c
10/21/77	20.00	0.00	2042.00	1.40	311.00	0.34	53.00	55.60	21.20	5.00	322.00	20.20	270.00
11/ 7/77	0.00	0.00	2550.00	c	c	c	c	c	c	c	c	c	c
11/21/77	20.00	0.00	2100.00	2.11	385.00	0.67	62.00	62.00	11.00	2.20	432.00	16.60	317.00
12/ 7/77	0.00	0.00	2500.00	c	c	c	c	c	c	c	c	c	c
12/21/77	20.00	0.00	2110.00	1.70	336.00	0.33	58.50	61.90	12.00	0.70	510.00	14.90	390.00
1/ 7/78	0.00	0.00	1580.00	c	c	c	c	c	c	c	c	c	c
1/21/78	NES	NES	1920.00	0.90	235.00	0.45	53.00	54.00	9.00	7.18	250.00	17.10	280.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
1/21/77	71.00	88.00	NES	NES	0.06	0.22	0.10	0.11	0.11	0.08	0 01	0.01
2/ 1/77	NES	NES	NES	NES	NES	NES	0.13	0.12	0.11	0.08	0.01	0.01
3/21/77	NES	NES	NES	NES	NES	0.09	0.10	NES	NES	NES	NES	NES
4/ 1/77	NES	NES	NES	0.02	0.08	NES	0.10	NES	0.20	0.27	NES	NES
4/14/77	60.00	250.00	NES	0.10	0.01	0.16	0.50	0.16	0.01	0.04	NES	NES
4/21/77	c	NES	c	NES	NES	c	c	c	NES	c	c	c
5/ 1/77	125.00	191.00	0.60	0.01	0.02	0.13	0.20	0.08	0.09	NES	0.02	0.01
5/14/77	62.00	28.70	NES	0.01	NES	0.07	0.10	NES	0.05	0.47	NES	0.01
5/21/77	c	c	c	c	c	c	c	c	c	c	c	c
6/ 7/77	65.00	30.80	0.10	0.01	0.01	0.20	0.10	0.06	0.06	0.30	0.01	NES
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	61.00	51.20	0.10	0.02	0.02	0.23	0.10	0.07	0.18	0.08	0.01	0.01
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	40.00	131.00	0.20	0.01	0.03	0.27	0.10	0.06	0.10	0.53	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	76.00	99.00	0.20	0.02	0.02	0.09	0.30	0.03	0.07	0.21	0.02	0.01
10/ 1/77	41.80	104.00	0.08	0.02	0.02	0.06	0.10	0.02	0.05	0.14	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	85.00	235.00	0.25	0.01	0.01	0.07	0.10	0.06	0.10	0.08	0.01	0.01
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
11/21/77	95.00	81.00	0.28	0.01	0.01	NES	0.10	0.04	0.13	0.94	0.01	0.01
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	117.00	198.00	0.23	0.03	0.02	0.19	0.18	0.08	0.06	0 22	0 01	0.01
1/ 7/78	c	c	c	c	c	c	c	c	c	c	c	c
1/21/78	62.00	79.00	0.23	0 01	0.01	0.02	0.20	0.02	0.08	0.12	0.01	0.01

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TABLE D-6. ANALYTICAL RESULTS: CONTROL LYSIMETER, 100 CM

	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	Tn	TOC	PO4	SO4	K	Na
1/14/77	NES	NES	NES	0.55	NES	0.73	NES	NES	10.00	NES	NES	16.00	NES
1/21/77	0.00	0.00	NES	0.62	NES	0.97	NES	NES	NES	4.50	NES	11.40	195.00
2/ 1/77	3.00	0.00	2218.00	0.95	329.00	NES	33.00	NES	4.00	3.64	777.00	16.20	NES
4/14/77	0.00	20.00	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
4/21/77	1300.00	20.00	NES	c	c	c	c	c	c	c	c	c	c
5/ 1/77	0.00	20.00	NES	0.89	279.00	1.12	41.70	43.00	NES	NES	740.00	14.50	310.00
5/ 7/77	NES	NES	2760.00	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
5/14/77	200.00	20.00	NES	0.66	300.00	0.18	NES	NES	18.00	3.60	893.00	12.00	NES
5/21/77	0.00	0.00	NES	0.17	251.00	c	c	NES	NES	3.40	c	NES	c
6/ 7/77	0.00	0.00	NES	0.52	215.20	0.58	NES	NES	NES	NES	NES	NES	NES
6/21/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
7/ 7/77	0.00	0.00	2670.00	0.25	231.00	1.17	NES	NES	39.00	5.50	740.00	13.00	153.00
7/21/77	50.00	0.00	2366.00	c	c	c	c	c	c	c	c	c	c
8/ 7/77	0.00	0.00	3176.00	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
8/21/77	0.00	0.00	2230.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	0.00	0.00	2078.00	1.12	317.00	1.50	3.20	4.00	37.00	0.19	620.00	13.10	275.00
9/14/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
10/ 1/77	0.00	0.00	2876.00	0.56	349.00	0.96	23.00	25.30	29.00	0.92	908.00	10.40	265.00
10/ 7/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
10/21/77	30.00	NES	NES	NES	NES	1.44	NES	NES	66.50	NES	1693.00	4.90	520.00
11/ 7/77	70.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
11/21/77	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
12/ 7/77	130.00	0.00	2386.00	c	c	c	c	c	c	c	c	c	c
12/21/77	80.00	0.00	1618.00	0.61	266.00	0.50	25.00	26.40	15.00	1.40	562.00	13.50	204.00
1/ 7/78	0.00	0.00	3676.00	c	c	c	c	c	c	c	c	c	c
1/21/78	NES	NES	2011.00	0.90	327.00	0.90	69.00	70.00	46.00	4.10	1000.00	11.80	350.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
1/14/77	304.00	NES	NES	0.03	0.06	0.05	0.10	0.12	0.05	0.26	0.01	0.01
1/21/77	315.00	NES	NES	0.01	0.10	0.08	0.10	0.01	0.09	0.69	0.03	0.01
2/ 1/77	NES	NES	NES	0.03	0.11	0.19	0.10	NES	0.13	0.17	0.01	0.01
4/ 1/77	NES	NES	NES	NES	NES	0.09	NES	NES	NES	NES	NES	NES
4/21/77	c	c	c	c	c	c	c	c	c	c	c	c
5/ 1/77	202.50	NES	0.60	0.03	0.04	0.21	0.05	0.02	0.16	1.02	0.02	0.01
5/14/77	NES	75.57	NES	0.01	0.09	0.06	0.10	NES	0.20	1.15	NES	0.01
5/21/77	c	57.20	c	0.01	c	c	0.10	c	0.08	NES	c	c
6/ 7/77	NES	58.00	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	147.00	73.60	0.10	0.03	0.03	0.09	0.10	0.09	0.15	1.02	0.01	NES
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	116.00	170.00	0.18	0.02	0.02	NES	0.10	0.03	0.13	0.48	NES	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	133.80	203.00	0.07	0.02	0.02	0.15	0.10	0.03	0.11	0.25	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	198.00	200.00	0.20	0.01	0.02	0.24	0.10	0.04	0.20	0.47	0.02	0.01
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	124.00	255.00	0.07	0.01	0.02	0.18	0.10	0.08	0.09	0.33	0.01	0.01
1/ 7/78	c	c	c	c	c.	c	c	c	c	c	c	c
1/21/78	215.00	120.00	0.32	0.01	0.01	0.09	0.10	0.03	0.13	0.63	0.01	0.01

TABLE D-7. ANALYTICAL RESULTS: TEST LYSIMETER, 300 CM

	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
11/21/76	0.00	0.00	NES	0.36	279.00	1.61	NES	NES	NES	NES	140.00	20.10	431.00
1/14/77	0.00	0.00	1062.00	1.69	NES	NES	NES	NES	NES	NES	NES	18.40	405.00
1/21/77	0.00	0.00	2500.00	1.27	171.00	NES	NES	NES	NES	NES	240.00	12.00	161.00
2/ 1/77	0.00	0.00	850.00	1.12	181.00	NES	31.00	NES	17.00	0.10	220.00	11.40	154.00
4/14/77	0.00	0.00	NES	1.10	NES	NES	NES	NES	NES	0.66	NES	19.00	NES
5/14/77	200.00	70.00	NES	0.44	225.00	0.55	34.70	35.80	4.00	0.10	334.00	9.50	165.00
6/ 7/77	0.00	0.00	1774.00	0.88	180.00	1.78	43.70	43.70	20.00	0.36	240.00	15.00	300.00
8/21/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
9/ 7/77	0.00	0.00	1870.00	1.40	236.00	1.70	65.30	65.30	12.00	0.10	326.00	7.00	337.00
9/14/77	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
10/ 1/77	0.00	0.00	2068.00	1.20	232.00	NES	87.00	NES	25.00	0.10	309.00	7.20	280.00
10/ 7/77	0.00	0.00	1474.00	c	c	c	c	c	c	c	c	c	c
10/21/77	0.00	0.00	1782.00	1.24	234.00	0.35	70.00	70.00	9.00	0.10	141.00	6.00	380.00
12/21/77	0.00	0.00	1946.00	1.40	228.00	0.70	69.00	70.70	0.50	0.10	260.00	6.30	315.00
1/21/78	NES	NES	1866.00	1.10	242.00	0.62	96.50	97.50	2.00	0.20	250.00	7.40	375.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
11/21/76	105.00	13.10	0.01	0.01	0.03	0.02	NES	0.01	0.10	0.06	0.00	0.01
1/14/77	96.00	61.00	0.03	0.00	0.05	0.06	NES	0.03	0.03	0.02	0.01	0.00
1/21/77	NES	NES	0.01	0.03	0.23	0.12	0.40	0.44	0.03	0.05	0.00	0.01
2/ 1/77	NES	NES	0.11	NES	0.13	0.07	0.40	0.12	0.06	0.03	NES	0.01
4/14/77	60.00	NES	NES	0.01	0.05	0.16	0.50	0.16	0.05	0.04	NES	NES
5/14/77	90.00	67.10	0.10	0.01	0.01	0.34	0.30	0.08	0.05	0.27	NES	0.01
6/ 7/77	NES	205.00	NES	0.01	0.02	0.08	NES	0.12	0.10	0.15	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	68.00	230.00	0.10	0.02	0.02	0.06	0.30	0.04	0.06	0.05	0.01	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	67.30	233.00	0.06	0.02	0.02	0.08	0.10	0.01	0.02	0.11	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	73.00	225.00	0.17	0.01	0.01	0.03	0.20	0.08	0.01	0.04	0.01	0.01
12/21/77	94.00	300.00	0.09	0.01	0.02	0.11	0.40	0.10	0.04	0.10	0.01	0.01
1/21/78	72.00	210.00	0.19	0.01	0.01	0.03	0.30	0.03	0.05	0.03	0.01	0.01

TABLE D-8. ANALYTICAL RESULTS: TEST WELL, ON-SITE, TOP

	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
2/21/77	NES	NES	2906.00	NES	NES	NES	NES	NES	9.00	NES	1100.00	NES	172.70
3/ 7/77	NES	NES	NES	NES	240.00	0.56	NES	NES	NES	0.10	NES	NES	NES
3/21/77	NES	NES	NES	0.55	NES	NES	NES	NES	NES	NES	NES	NES	NES
4/ 7/77	NES	NES	NES	NES	287.00	NES	NES	NES	NES	NES	NES	NES	NES
4/14/77	NES	NES	NES	NES	263.00	NES	NES	NES	NES	NES	NES	NES	NES
5/ 1/77	NES	NES	NES	NES	229.00	NES	NES	NES	24.00	1.70	1800.00	14.30	NES
5/14/77	0.00	0.00	3660.00	0.19	256.50	0.62	45.00	45.10	7.00	0.80	1780.00	14.50	258.20
5/21/77	0.00	0.00	3620.00	0.44	267.60	c	c	c	c	c	c	15.40	375.00
6/ 7/77	0.00	0.00	3600.00	1.22	268.00	0.50	36.80	NES	12.00	1.10	1200.00	13.20	167.00
6/21/77	0.00	0.00	3432.00	c	c	c	c	c	c	c	c	c	c
7/ 7/77	0.00	0.00	3320.00	0.17	233.00	1.36	35.50	35.50	11.00	0.18	2110.00	15.90	171.00
7/21/77	0.00	0.00	3294.00	c	c	c	c	c	c	c	c	c	c
8/ 7/77	0.00	0.00	3390.00	1.07	276.00	1.21	41.20	41.30	9.00	0.32	1350.00	10.20	350.00
8/21/77	0.00	0.00	2565.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	0.00	0.00	2812.00	1.25	287.00	1.58	46.00	46.00	7.50	0.07	1460.00	9.00	332.00
9/14/77	0.00	0.00	2820.00	c	c	c	c	c	c	c	c	c	c
10/ 1/77	NES	NES	NES	1.04	257.00	1.34	32.00	32.80	13.00	0.10	1131.00	9.60	308.00
10/ 7/77	0.00	0.00	2824.00	c	c	c	c	c	c	c	c	c	c
10/21/77	0.00	0.00	2952.00	0.97	250.00	1.50	33.00	35.30	11.50	0.10	1310.00	9.10	345.00
11/ 7/77	0.00	0.00	2960.00	c	c	c	c	c	c	c	c	c	c
11/21/77	0.00	0.00	2498.00	0.93	279.00	1.19	40.00	40.00	1.50	0.11	1125.00	8.10	316.00
12/ 7/77	0.00	0.00	2576.00	c	c	c	c	c	c	c	c	c	c
12/21/77	0.00	0.00	2364.00	1.40	246.00	0.70	48.00	53.00	1.50	0.10	1035.00	7.70	306.00
1/ 7/78	0.00	0.00	2274.00	c	c	c	c	c	c	c	c	c	c
1/21/78	0.00	0.00	2812.00	1.30	247.00	0.65	41.50	42.50	0.50	0.10	1145.00	12.60	380.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
2/21/77	NES	NES	NES	0.04	0.22	0.05	0.02	NES	0.10	0.06	NES	NES
3/14/77	NES	NES	NES	0.01	NES	NES	NES	NES	NES	NES	NES	NES
3/21/77	NES	NES	NES	0.01	NES	NES	NES	NES	NES	NES	NES	NES
4/ 7/77	NES	NES	NES	0.02	NES	NES	NES	NES	NES	NES	NES	NES
5/ 1/77	NES	NES	NES	NES	0.06	0.03	NES	NES	0.09	0.04	NES	NES
5/14/77	321.00	NES	0.12	0.01	0.20	0.07	0.01	0.17	0.06	0.06	NES	0.01
5/21/77	c	NES	c	0.01	c	c	c	c	0.06	0.07	c	c
6/ 7/77	215.00	NES	0.30	0.03	0.11	0.03	0.20	0.19	0.11	0.08	0.01	0.01
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	238.00	13.09	0.10	0.05	0.19	0.07	0.10	0.15	0.12	0.08	0.02	0.01
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	NES	85.50	0.11	0.01	0.20	0.03	0.20	0.15	0.07	0.07	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	136.00	119.00	0.35	0.02	0.02	0.03	0.20	0.02	0.03	0.04	0.01	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	125.60	72.40	0.08	0.02	0.02	0.05	0.10	0.02	0.16	0.03	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	130.00	52.00	0.03	0.02	0.02	0.02	0.20	0.04	0.15	0.03	0.01	0.01
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
11/21/77	130.00	62.00	0.05	0.01	0.01	0.07	0.20	0.07	0.05	0.06	0.01	0.01
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	165.00	114.00	0.03	0.01	0.03	0.06	0.29	0.12	0.05	0.03	0.01	0.01
1/ 7/78	c	c	c	c	c	c	c	c	c	c	c	c
1/21/78	145.00	63.00	0.12	0.01	0.01	0.01	0.30	0.03	0.08	0.03	0.01	0.01

TABLE D-9. ANALYTICAL RESULTS: TEST WELL, ON-SITE BOTTOM

	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
2/21/77	NES	NES	NES	NES	NES	1.20	NES	NES	5.50	0.10	NES	NES	177.10
3/ 7/77	NES	NES	NES	NES	230.00	1.71	NES	NES	NES	0.10	NES	NES	NES
5/21/77	0.00	0.00	3600.00	0.40	301.30	c	c	c	c	c	c	15.10	375.00
6/ 7/77	0.00	0.00	3688.00	1.22	315.00	0.69	35.30	35.90	7.00	0.42	NES	15.50	167.20
6/21/77	0.00	0.00	3444.00	c	c	c	c	c	c	c	c	c	c
7/ 7/77	0.00	0.00	3700.00	0.29	263.00	0.95	42.20	42.20	13.00	0.50	1201.00	14.20	167.00
7/21/77	0.00	0.00	4452.00	c	c	c	c	c	c	c	c	c	c
8/ 7/77	0.00	0.00	3798.00	1.20	398.00	0.97	30.00	30.40	11.00	1.11	1600.00	12.50	398.00
8/21/77	0.00	0.00	2679.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	0.00	0.00	3570.00	1.60	313.00	1.77	29.50	29.50	7.50	0.18	1630.00	3.90	350.00
9/14/77	0.00	0.00	3694.00	c	c	c	c	c	c	c	c	c	c
10/ 1/77	NES	NES	NES	1.19	300.00	1.60	43.00	43.60	NES	0.10	867.00	3.70	310.00
10/ 7/77	0.00	0.00	3624.00	c	c	c	c	c	c	c	c	c	c
10/21/77	0.00	0.00	3550.00	1.50	301.00	2.00	37.00	37.00	16.80	0.10	1532.00	3.30	360.00
11/ 7/77	0.00	0.00	3680.00	c	c	c	c	c	c	c	c	c	c
11/21/77	0.00	0.00	3380.00	1.42	321.00	1.33	52.00	52.00	NES	0.22	1310.00	3.80	318.00
12/ 7/77	0.00	0.00	2730.00	c	c	c	c	c	c	c	c	c	c
12/21/77	0.00	0.00	3130.00	1.50	265.00	0.85	34.00	35.00	6.00	0.10	1240.00	5.00	315.00
1/ 7/78	0.00	0.00	3426.00	c	c	c	c	c	c	c	c	c	c
1/21/78	0.00	0.00	3756.00	1.10	235.00	0.90	41.00	42.00	15.50	0.10	1630.00	8.90	350.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
2/21/77	126.00	64.60	NES	0.06	0.38	NES	0.30	NES	0.08	0.07	NES	NES
5/21/77	c	NES	c	0.01	c	c	c	c	0.06	0.06	c	c
6/ 7/77	164.00	NES	0.13	0.04	0.14	0.04	0.10	0.18	0.13	0.07	0.01	0.01
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	229.00	81.29	0.10	0.06	0.22	0.08	0.10	0.10	0.17	0.06	0.02	0.01
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	NES	NES	0.17	0.01	0.15	0.07	0.20	0.23	0.15	0.18	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	146.00	255.00	0.32	0.02	0.02	0.02	0.20	0.03	0.02	0.11	0.01	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	143.00	380.00	0.08	0.02	0.02	0.06	0.10	0.03	0.06	0.03	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	155.00	330.00	0.10	0.03	0.02	0.02	0.20	0.07	0.20	0.05	0.01	0.01
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
11/21/77	162.00	260.00	0.08	0.01	0.01	0.07	0.10	NES	0.04	0.06	0.01	0.01
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	166.00	312.00	0.05	0.01	0.05	0.06	0.27	0.11	0.04	0.06	0.01	0.01
1/ 7/78	c	c	c	c	c	c	c	c	c	c	c	c
1/21/78	200.00	260.00	0.15	0.01	0.01	0.03	0.30	0.03	0.06	0.03	0.01	0.01

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TABLE D-10. ANALYTICAL RESULTS: TEST WELL, LATERAL, TOP

	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
3/21/77	0.00	0.00	NES	NES	NES	NES	NES	NES	NES	NES	900.00	NES	NES
4/ 7/77	NES	NES	NES	0.20	552.00	NES	NES	NES	NES	NES	NES	NES	NES
4/14/77	NES	NES	NES	NES	550.00	NES	NES	NES	NES	NES	NES	NES	NES
5/ 1/77	NES	NES	NES	NES	382.00	NES	NES	NES	NES	NES	NES	NES	NES
5/14/77	200.00	0.00	3710.00	0.40	403.00	1.31	52.90	60.00	35.00	NES	NES	5.10	239.55
5/21/77	0.00	0.00	3550.00	0.38	466.90	c	c	c	c	c	c	5.60	259.00
6/ 7/77	0.00	0.00	3628.00	1.25	467.00	0.44	39.90	39.50	6.00	1.10	1000.00	4.36	152.00
6/21/77	0.00	0.00	3384.00	c	c	c	c	c	c	c	c	c	c
7/ 7/77	0.00	0.00	3440.00	0.27	397.00	1.33	58.50	59.30	22.00	0.39	1130.00	5.50	156.00
7/21/77	0.00	0.00	3648.00	c	c	c	c	c	c	c	c	c	c
8/ 7/77	0.00	0.00	3724.00	0.73	485.00	1.33	41.60	41.60	14.00	0.54	800.00	4.10	286.00
8/21/77	130.00	0.00	2690.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	50.00	0.00	3268.00	0.94	533.00	1.68	50.30	59.30	NES	0.08	900.00	5.00	320.00
9/14/77	0.00	0.00	3432.00	c	c	c	c	c	c	c	c	c	c
10/ 1/77	16000.00	0.00	3324.00	0.80	548.00	1.60	53.00	53.50	3.00	0.22	867.00	6.00	252.00
10/ 7/77	0.00	0.00	3222.00	c	c	c	c	c	c	c	c	c	c
10/21/77	0.00	0.00	3324.00	0.62	540.00	1.76	57.00	57.60	14.00	0.10	786.00	5.10	310.00
11/ 7/77	0.00	0.00	3200.00	c	c	c	c	c	c	c	c	c	c
11/21/77	0.00	0.00	2886.00	0.77	569.20	1.30	51.00	51.00	0.50	0.10	895.00	5.60	220.00
12/ 7/77	20.00	0.00	3000.00	c	c	c	NES	c	c	c	c	c	c
12/21/77	0.00	0.00	2640.00	1.00	501.00	1.10	56.50	57.50	3.00	0.10	865.00	5.80	297.00
1/ 7/78	0.00	0.00	2564.00	c	c	c	c	c	c	c	c	c	c
1/21/78	0.00	0.00	2774.00	0.70	366.00	0.86	48.00	49.00	10.00	0.90	1165.00	5.10	345.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
3/21/77	NES	NES	NES	0.02	NES	NES	0.04	NES	NES	NES	NES	NES
4/ 7/77	NES	NES	NES	0.03	NES	0.12	NES	NES	NES	NES	NES	NES
5/14/77	285.00	89.43	0.10	0.01	0.07	0.05	0.10	0.17	0.07	0.03	NES	NES
5/21/77	c	100.89	c	0.01	c	c	c	c	0.05	0.07	c	c
6/ 7/77	177.00	113.00	0.10	0.05	0.02	0.03	0.10	0.18	0.15	0.06	0.01	0.01
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	270.00	83.31	0.10	0.04	0.11	0.06	0.10	0.10	0.12	0.07	0.01	0.01
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	91.00	246.00	0.09	0.01	0.07	0.06	0.10	0.15	0.15	0.08	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	175.00	265.00	0.14	0.02	0.02	0.09	0.10	0.03	0.03	0.03	0.01	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	174.80	242.00	0.06	0.02	0.02	0.07	0.10	0.07	0.11	0.05	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	210.00	215.00	0.10	0.02	0.01	0.04	0.10	0.10	0.20	0.08	0.01	0.01
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
11/21/77	210.00	130.00	0.07	0.01	0.01	0.09	0.10	0.03	0.06	0.07	0.01	0.01
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	231.00	186.00	0.15	0.01	0.02	0.13	0.15	0.15	0.06	0.04	0.01	0.01
1/ 7/78	c	c	c	c	c	c	c	c	c	c	c	c
1/21/78	220.00	165.00	0.30	0.01	0.01	0.02	0.02	0.03	0.07	0.03	0.01	0.01

TABLE D-11. ANALYTICAL RESULTS: TEST WELL, LATERAL, BOTTOM

	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
5/21/77	0.00	0.00	3470.00	0.62	488.00	c	c	c	c	0.80	c	5.70	277.00
6/ 7/77	0.00	0.00	3744.00	1.15	488.00	0.50	66.00	66.80	8.90	1.78	920.00	4.90	155.00
6/21/77	0.00	0.00	3660.00	c	c	c	c	c	c	c	c	c	c
7/ 7/77	0.00	0.00	3960.00	0.71	NES	1.05	60.00	60.80	25.00	1.43	1100.00	6.40	157.00
7/21/77	490.00	0.00	3766.00	c	c	c	c	c	c	c	c	c	c
8/ 7/77	0.00	0.00	3772.00	0.55	546.00	1.33	62.90	63.20	11.00	1.03	930.00	5.00	297.00
8/21/77	NES	NES	3031.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	50.00	0.00	3264.00	1.08	604.00	1.34	75.20	75.20	8.00	0.13	930.00	6.00	320.00
9/14/77	0.00	0.00	3510.00	c	c	c	c	c	c	c	c	c	c
10/ 1/77	92000.00	0.00	3570.00	0.62	550.00	1.28	67.00	68.30	44.00	0.10	980.00	6.90	260.00
10/ 7/77	70.00	0.00	3260.00	c	c	c	c	c	c	c	c	c	c
10/21/77	40.00	0.00	3158.00	0.75	555.00	1.73	62.00	62.00	20.20	0.10	766.00	5.20	302.00
11/ 7/77	0.00	0.00	3300.00	c	c	c	c	c	c	c	c	c	c
11/21/77	0.00	0.00	3076.00	0.58	575.00	1.09	54.00	54.00	0.50	0.27	965.00	6.30	218.00
12/ 7/77	20.00	0.00	2992.00	c	c	c	c	c	c	c	c	c	c
12/21/77	50.00	0.00	2778.00	1.30	515.00	0.79	64.50	65.50	9.00	0.10	895.00	6.00	258.00
1/ 7/78	0.00	0.00	2616.00	c	c	c	c	c	c	c	c	c	c
1/21/78	0.00	0.00	3020.00	0.70	445.00	0.84	52.00	53.00	5.50	0.90	825.00	5.90	330.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
5/21/77	c	92.70	c	0.01	c	c	c	c	0.06	0.06	c	c
6/ 7/77	188.00	118.00	0.10	0.04	0.06	0.03	0.10	0.20	0.19	0.06	0.01	0.01
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	232.00	118.20	0.10	0.05	0.07	NES	0.10	0.22	0.20	0.09	0.02	0.01
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	102.00	253.00	0.13	0.01	0.12	0.06	0.10	0.19	0.14	0.07	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	200.00	195.00	0.29	0.02	0.03	0.04	0.10	0.04	0.02	0.02	0.01	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	187.00	276.00	0.10	0.02	0.02	0.09	0.10	0.04	0.09	0.02	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	208.00	220.00	0.07	0.01	0.02	0.03	0.10	0.06	0.20	0.03	0.01	0.01
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
11/21/77	212.00	119.00	0.10	0.01	0.01	0.08	0.10	0.04	0.12	0.06	0.01	0.01
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	247.00	255.00	0.09	0.03	0.02	0.10	0.10	0.13	0.06	0.06	0.01	0.01
1/ 7/78	c	c	c	c	c	c	c	c	c	c	c	c
1/21/78	215.00	110.00	0.12	0.01	0.01	0.03	0.20	0.03	0.07	0.03	0.01	0.01

TABLE D-12. ANALYTICAL RESULTS: TEST WELL, DOWNSTREAM, TOP

	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
3/21/77	NES	NES	NES	NES	341.00	NES	NES	NES	NES	NES	1350.00	NES	NES
4/ 7/77	NES	NES	NES	1.12	NES	NES	NES	NES	NES	NES	NES	NES	NES
5/ 1/77	NES	NES	NES	NES	215.00	NES	NES	NES	NES	NES	NES	NES	NES
5/14/77	200.00	0.00	4190.00	0.40	367.00	1.10	52.90	54.00	12.00	0.60	2080.00	5.10	247.15
5/21/77	0.00	0.00	4050.00	0.44	364.90	c	c	NES	NES	0.90	NES	5.70	345.00
6/ 7/77	0.00	0.00	4220.00	1.62	365.00	0.59	64.50	65.50	10.00	1.61	1600.00	4.70	165.00
6/21/77	0.00	0.00	4068.00	c	c	c	c	c	c	c	c	c	c
7/ 7/77	0.00	0.00	4260.00	0.45	314.00	1.27	52.40	52.80	32.00	0.44	2330.00	4.70	166.00
7/21/77	50.00	0.00	4222.00	c	c	c	c	c	c	c	c	c	c
8/ 7/77	0.00	0.00	3936.00	0.94	369.00	1.49	52.40	53.40	15.00	0.21	1250.00	3.10	320.00
8/21/77	20.00	0.00	3386.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	130.00	0.00	3892.00	1.51	350.00	1.63	36.70	37.70	14.00	0.10	1680.00	4.00	385.00
9/14/77	170.00	0.00	4066.00	c	c	c	c	c	c	c	c	c	c
10/ 1/77	0.00	0.00	4222.00	1.28	353.00	1.60	40.00	43.50	3.00	0.10	1583.00	4.40	310.00
10/ 7/77	70.00	0.00	3880.00	c	c	c	c	c	c	c	c	c	c
10/21/77	230.00	0.00	3936.00	1.29	368.00	1.93	44.50	45.70	18.70	0.10	1068.00	3.30	365.00
11/ 7/77	20.00	0.00	4040.00	c	c	c	c	c	c	c	c	c	c
11/21/77	0.00	0.00	3750.00	1.16	577.50	1.16	65.00	65.00	6.00	0.10	2000.00	4.20	315.00
12/ 7/77	0.00	0.00	3828.00	c	c	c	c	c	c	c	c	c	c
12/21/77	5400.00	0.00	3094.00	1.10	343.00	0.85	61.00	61.40	1.00	0.10	1730.00	5.00	318.00
1/ 7/78	0.00	0.00	3452.00	c	c	c	c	c	c	c	c	c	c
1/21/78	0.00	0.00	NES	0.60	327.00	0.65	59.00	60.00	18.00	0.90	1390.00	7.00	380.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
3/21/77	NES	NES	NES	0.01	NES	NES	NES	NES	NES	NES	NES	NES
4/ 7/77	NES	NES	NES	0.06	NES	0.08	NES	NES	NES	NES	NES	NES
5/14/77	273.00	132.33	0.10	0.02	0.14	0.07	0.10	0.15	0.07	0.08	0.01	NES
5/21/77	c	132.16	NES	0.01	c	c	NES	NES	0.05	0.09	NES	NES
6/ 7/77	180.00	175.40	0.30	0.05	0.24	0.05	0.30	0.21	0.19	0.08	0.01	0.01
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	241.00	133.87	0.10	0.02	0.18	0.09	0.20	0.14	0.18	0.05	0.02	0.01
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	NES	385.00	0.09	0.01	0.05	0.05	0.30	0.15	0.12	0.06	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	145.00	525.00	0.10	0.02	0.02	0.03	0.10	0.04	0.02	0.03	0.01	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	158.10	512.00	0.07	0.02	0.02	0.06	0.10	0.04	0.09	0.02	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	170.00	300.00	0.10	0.01	0.02	0.02	0.20	0.09	0.20	0.04	0.01	0.01
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
11/21/77	178.00	233.00	0.14	0.01	0.01	0.09	0.20	0.06	0.13	0.06	0.01	0.01
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	231.00	288.00	0.15	0.01	0.03	0.09	0.21	0.13	0.07	0.06	0.01	0.01
1/ 7/78	c	c	c	c	c	c	c	c	c	c	c	c
1/21/78	210.00	265.00	0.20	0.01	0.01	0.01	0.50	0.03	0.09	0.02	0.01	0.01

TABLE D-13. ANALYTICAL RESULTS: TEST WELL, DOWNSTREAM, BOTTOM

	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
5/21/77	0.00	0.00	3950.00	0.47	381.70	c	c	c	c	0.30	c	5.70	c
6/ 7/77	20.00	0.00	4190.00	0.69	381.00	0.61	40.70	42.00	12.00	1.97	1500.00	4.50	165.00
6/21/77	0.00	0.00	4090.00	c	c	c	c	c	c	c	c	c	c
7/ 7/77	0.00	0.00	4410.00	0.42	408.00	1.26	42.10	43.20	38.00	1.14	2330.00	8.20	167.00
7/21/77	330.00	20.00	4252.00	c	c	c	c	c	c	c	c	c	c
6/ 7/77	0.00	0.00	4460.00	1.28	390.00	0.33	30.40	31.70	15.00	0.98	1450.00	5.20	330.00
8/21/77	50.00	0.00	3564.00	c	c	c	c	c	c	c	c	c	c
9/ 7/77	50.00	0.00	3900.00	1.57	345.00	1.69	46.90	47.20	9.00	0.13	1680.00	4.00	363.00
9/14/77	1300.00	0.00	4084.00	c	c	c	c	c	c	c	c	c	c
10/ 1/77	3500.00	0.00	NES	1.34	355.00	1.60	39.00	40.60	20.00	0.10	1583.00	4.40	310.00
10/ 7/77	230.00	0.00	3986.00	c	c	c	c	c	c	c	c	c	c
10/21/77	170.00	0.00	3992.00	1.29	345.00	1.62	42.00	43.50	19.50	0.10	1572.00	4.30	380.00
11/ 7/77	0.00	0.00	3960.00	c	c	c	c	c	c	c	c	c	c
11/21/77	170.00	0.00	3730.00	0.96	387.00	1.09	47.00	47.00	6.50	0.27	1415.00	5.70	275.00
12/ 7/77	0.00	0.00	3702.00	c	c	c	c	c	c	c	c	c	c
12/21/77	1600.00	0.00	3754.00	1.30	339.00	0.76	58.50	62.10	0.50	0.12	1310.00	4.80	321.00
1/ 7/78	0.00	0.00	NES	c	c	c	c	c	c	c	c	c	c
1/21/78	0.00	0.00	NES	1.20	327.00	0.76	52.00	53.00	1.00	0.90	1435.00	5.10	335.00

	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
5/21/77	c	127.49	c	0.01	c	c	c	c	0.06	0.20	c	c
6/ 7/77	180.00	175.00	0.10	0.03	0.06	0.16	0.30	0.20	0.17	0.12	0.01	0.01
6/21/77	c	c	c	c	c	c	c	c	c	c	c	c
7/ 7/77	249.00	134.20	0.10	0.03	NES	0.09	0.10	0.13	0.15	0.08	0.02	0.01
7/21/77	c	c	c	c	c	c	c	c	c	c	c	c
8/ 7/77	NES	NES	0.13	0.01	0.05	0.07	0.30	0.13	0.16	0.13	0.01	0.01
8/21/77	c	c	c	c	c	c	c	c	c	c	c	c
9/ 7/77	156.00	375.00	0.22	0.02	0.03	0.03	0.40	0.04	0.02	0.03	0.01	0.01
9/14/77	c	c	c	c	c	c	c	c	c	c	c	c
10/ 1/77	143.60	524.00	0.13	0.02	0.02	0.06	0.10	0.02	0.09	0.02	0.01	0.01
10/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
10/21/77	173.00	515.00	0.05	0.01	0.06	0.02	0.20	0.06	0.20	0.04	0.01	0.01
11/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
11/21/77	178.00	242.00	0.22	0.01	0.01	0.07	0.20	0.07	0.13	0.08	0.01	0.01
12/ 7/77	c	c	c	c	c	c	c	c	c	c	c	c
12/21/77	225.00	315.00	0.21	0.02	0.03	0.08	0.20	0.18	0.13	0.03	0.01	0.01
1/ 7/78	c	c	c	c	c	c	c	c	c	c	c	c
1/21/78	215.00	250.00	0.28	0.01	0.01	0.02	0.30	0.03	0.09	0.02	0.01	0.01

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TABLE D-14. INDIVIDUAL SOIL ANALYSES, INITIAL SAMPLING (OCTOBER, 1976)[a]

Site	Depth (cm)	B	Cl	F	NO_3-N[b]	N[c]	PO_4[b]	P[b]	P[b] Organic	K	K	Na	Na	Ca	Ca
		WE[d]	WE	WE	WE[b]	T[c]	WE[b]	AE[f]	T[b]	WE[b]	EX[g]	WE[b]	AE[b]	WE[b]	EX
Test	1	8.1	200	14	160	920	12	365	180	108	1650	206	10500	162	3870
		7.5		9	3	1000	18	1440	150	100	1880	246	9360	30	5750
		7.9		9		979									
	3	7.2	150	25	50	890	10	405	260	109	1650	207	12600	192	3850
		5.3		15	5	575	21	760	40	116	1920	227	9720	16	3590
	10	6.4	100	9	35	1005	14	438	30	120	1610	214	11800	171	3850
		6.5		16	2	945	26	1280	< 20	123	1720	227	10300	14	3870
	30	6.8	250	11	70	980	13	437	< 20	111	1240	222	10500	142	3890
		6.1		22	4	875	32	840	20	134	1760	210	6300	14	3720
		6.4		9		920									
	100	5.8	150	4	110	1130	5.2	488	100	60	880	230	11700	124	2430
		7.1		4	2	1100	15	596	198	40	690	246	8460	51	2570
	200	5.2	150	9	125	1090	4.8	464	140	36	410	251	17700	121	3240
		5.3		11	33	1110	3.6	800	150	42	790	210	8820	5	1170
	300	3.7	125	9	90	886	< 1.0	503	600	29	760	256	13000	124	4030
		5.0		27	2	1070	2.3	1080	10	15	1246	258	11340	57	3780

(continued)

TABLE D-14 (continued)

Site	Depth (cm)	B	Cl	F	NO_3-N^b	N^c	PO_4^b	P^b	P Organic	K		Na		Ca	
		WE^d	WE	WE	WE^b	T^c	WE^b	AE^b	T^b	WE^b	EX^g	WE^b	AE^b	WE^b	EX
Control	1	5.4	175	8	250	740	12	259	120	97	1700	227	9100	94	2400
		4.9		6	51	830	42	1020	512	161	1640	242	2940	10	2380
		5.1		8		950									
	3	5.0	100	2	110	620	17	264	460	73	1600	158	9300	35	3120
		4.7		2	10	688	42	1120	102	196	1620	177	2610	9	2510
	10	3.9	250	2	15	491	13	310	460	118	1610	246	10000	81	2730
		4.3		6	2	495	18	960	<20	145	1380	240	2940	26	2510
	30	4.1	175	9	50	596	32	302	60	92	1620	124	12600	32	3080
		3.9		6	37	700	18	1040	<20	190	1560	165	2880	18	3140
		5.3		7		400									
	100	4.4	175	4	50	610	8.0	212	240	54	1260	156	11800	42	2490
		3.5		4	1	530	9.2	620	250	41	1150	159	4560	150	2700
	200	4.9	150	10	35	665	0.8	404	160	61	1630	188	13400	160	2640
		5.8		10	35	710	5.4	440	920	51	1210	165	9180	188	2460
		4.6		6		626									
	300	4.5	125	3	50	460	<1.0	363	120	37	1240	158	11300	102	2430
		5.4		6	10	435	7.2	260	622	61	1200	236	12100	228	2760
		5.6		3		438									

(continued)

TABLE D-14 (continued)

Site	Depth (cm)	T^b	Mg AE^b	Mg WE^b	EX	CEC^h	Ag T	Ag AE^b	Ba T^b	Cd T^b	Cd AE^b	Cr T	Cr AE	Cu T^b	Cu AE^b	Mn T^b	Mn AE
Test	1	7500	4700	98	558	22.8	<20	1.0	1360	<5	1.8	102	22	22		426	180
		8600	951	26	543	21.0	<20	< 1.0	520	20	1.4	120	7	34	3.1	412	243
													23				276
	3	5810	3550	114	449	16.3	<20	< 1.0	1140	< 5	1.7	176	14	22	1.7	358	179
		4600	923	22	329	17.9	<20	< 1.0	620	12	1.3	112	20	28		402	171
													24				
	10	7720	4500	97	368	15.1	<20	< 1.0	560	6	1.8	120	20	34	1.4	432	217
		13000	1050	24	590	16.3	<20	< 1.0	560	< 5	2.2	150	12	28		516	184
	30	7480	4750	104	470	16.2	<20	< 1.0	1700	< 5	1.8	158	10	28	1.9	514	192
		4200	940	21	590	11.5	<20	< 1.0	520	14	1.7	102	18	24		352	170
																	255
	100	6380	3250	94	881	12.5	<20	< 1.0	860	< 5	1.4	136	15	26	1.5	420	199
		6600	880	21	307	12.7	<20	< 1.0	440	10	1.4	100	18	22		418	153
	200	4950	3500	85	1610	10.4	<20	< 1.0	820	< 5	1.4	108	12	28	4.6	338	134
		6200	810	22	155	8.1	<20	< 1.0	1100	< 5	1.2	92	21	26		376	164
									1060								
	300	9800	4400	125	1220	11.1	<20	< 1.0	3280	< 5	2.7	113	20	30	0.4	364	121
			1410	37	310	8.7	<20	< 1.0	740	6	0.9	98	16	26		450	173

(continued)

TABLE D-14 (continued)

Site	Depth (cm)	T^b	Mg AE^b	Mg WE^b	Mg EX	CEC^h	Ag T	Ag AE^b	Ba T^b	Cd T^b	Cd AE^b	Cr T^b	Cr AE	Cu T^b	Cu AE	Mn T^b	Mn AE
Control	1	4670	2600	151	313	22.7	<20	<1.0	810	< 5	1.5	160	20	68	3.0	362	120
		7200	1150	22	353	18.5	<20	<1.0	60	6	1.5	124	5	30		464	201
													12				177
	3	5610	2500	78	384	13.0	<20	<1.0	638	6	1.7	170	11	28	2.5	636	140
	10	7400	890	22	532	11.0	<20	<1.0	126	<5	2.1	128	15	32		452	182
		5940	2770	150	375	10.4	<20	<1.0	1140	6	2.1	158	10	34	2.0	596	142
		5200	1200	36	604	9.8	<20	<1.0	106	<5	1.4	138	13	30		434	135
	30	4000	3250	42	599	7.7	<20	<1.0	702	<5	2.0	156	2	28	1.2	304	186
		5400	480	18	--	7.7	<20	<1.0	124	<5	1.1	142	12	24		366	152
													3				130
	100	6070	3300	29	616	9.3	<20	<1.0	664	<5	1.8	118	13	70	1.5	408	155
		11400	750	36	575	8.3	<20	<1.0	120	6	1.2	144	13	24		416	163
	200	3600	2750	80	306	12.8	<20	<1.0	748	<5	1.5	136	ND	26	1.8	328	149
		--	680	26	1150	8.8	<20	<1.0	118	<5	0.8	126	6	20		344	205
													7				
	300	4550	2250	50	216	11.9	<20	<1.0	1580	<5	1.3	154	6	24	0.2	380	165
		16600	660	18	411	18.3	<20	<1.0	100	<5	1.2	172	13	34		440	231
													11				

(continued)

TABLE D-14 (continued)

Site	Depth (cm)	Mo	Ni		Pb		Zn		As		Hg		Se	
		T^b	T^b	AE	T^b	AE^b	T^b	AE^b	T^b	AE	T	AE	T	AE
Test	1	<20	88	19	60	5.7	--	12	5.6				< 2.0	0.1
		<20	94	15	66	2.0	--	4.3	<2.0	0.5	<1.0	0.09	< 2.0	0.10
				18			--							
	3	<20	78	15	88	5.7	--	11	9.0	0.5	3.5	0.05	< 2.0	0.10
		<20	84	19	46	2.8	--	4.2	<2.0		<1.0		< 2.0	
	10	20	88	14	72	6.0	--	13	4.8	0.6	<1.0		< 2.0	0.10
		<20	98	18	30	2.0	--	4.2			<1.0	0.05	< 2.0	
	30	20	94	15	70	6.3	--	13	<2.0	1.4	<1.0		< 2.0	0.10
		<20	78	25	44	7.0	--	3.6	2.9		<1.0	0.05	< 2.0	
	100	<20	96	18	64	5.5	--	7.5	3.0	0.3	<1.0	0.05	< 2.0	0.10
		<20	96	20	30	3.8	--	2.5	<2.0		<1.0		< 2.0	
	200	<20	80	15	62	5.5	5.0	8.5	4.8	0.4	<1.0	0.05	< 2.0	0.10
		<20	62	17	38	2.2	5.0	3.7	2.1		<1.0		< 2.0	
	300	24	78	15	66	5.3		13	3.6	0.4	<1.0	0.05	< 2.0	0.10
		<20	72	17	22	1.9	5.0	3.1	<2.0		<1.0		< 2.0	

(continued)

TABLE D-14 (continued)

Site	Depth (cm)	Mo	Ni		Pb		Zn		As		Hg		Se	
		T^b	T^b	AE	T^b	AE^b	T^b	AE^b	T^b	AE	T	AE	T	AE
Control	1	60	64	12	116	99	--	12	14.0	1.7	< 1.0		< 2.0	<0.10
		< 20	44	17	128	30	--	4.9	3.6		< 1.0	< 0.05	< 2.0	
				3										
	3	60	78	17	138	87	--	14	10.0	1.7	< 1.0		< 2.0	<0.10
		< 20	70	11	92	31	--	4.7	2.7		1.6	0.05	< 2.0	
	10	40	90	12	136	81	--	11	10.0	1.7	< 1.0		< 2.0	<0.10
		< 20	66	13	116	29	< 5.0	3.2	4.4		< 1.0	0.08	< 2.0	
	30	60	50	10	40	8.0	--	11	6.0	1.0	< 1.0		< 2.0	<0.10
		< 20	58	10	52	2.0	--	3.3	2.2		< 1.0	< 0.05	< 2.0	
				8	44	1.8	--	1.8						
	100	40	70	6	66	7.0	--	14	8.0	0.5	< 1.0		< 2.0	<0.10
		< 20	70	19	44	1.8	--	1.8	< 2.0		< 1.0	< 0.05	< 2.0	
	200	60	46	5	46	5.4	< 5.0	6.4	5.0	0.3	< 1.0		< 2.0	<0.10
		< 20	57	22	36	1.7	< 5.0	2.3	< 2.0		< 1.0	0.05	< 2.0	
				12			--							
	300	60	80	3	84	4.2	< 5.0	8.2	2.4	0.4	< 1.0		< 2.0	
		< 20	52	7	24	1.7	< 5.0	1.5	< 2.0		< 1.0	0.05	< 2.0	<0.10
				13										

[a] All values in mg/kg unless noted.
[b] Analyses done on a composite of three samples.
[c] N = NO_3-N + KjN.
[d] WE = water extractible.
[e] T = total.
[f] AE = acid extractible.
[g] EX = exchangeable.
[h] mg/100 gm

TABLE D-15. INDIVIDUAL SOIL ANALYSES, FINAL SAMPLING (SEPTEMBER, 1977)[a]

Site	Depth (cm)	B	Cl	F	NO_3-N[b]	N[b]	PO_4-P	P	P Organic	K		Na	Ca		
		WE[c]	WE	WE	WE	T[d]	WE	AE[e]	T	WE	EX[f]	WE	AE	WE	EX
Test	1	2.0	290	6	53	723	14	404	160	91	1680	280	10100	20	3540
		2.5	250	6	76	686	9.6	394	70	110	1520	290	9630	65	3430
	3	2.8	290	4	75	996	14	415	80	150	1740	280	10100	77	3420
		1.4	290	5	61	808	31	424	70	140	1790	270	10600	77	3490
	10	2.0	207	7	62	654	14	443	220	120	1670	250	10300	60	3566
		2.0	249	5	64	937	15	404	200	120	1660	260	9900	66	3750
	30	1.5	166	5	93	682	11	300	110	45	1220	210	9450	16	3610
		1.7	145	5	45	380	16	443	120	23	1100	220	9720	19	3610
	100	2.0	145	8	9	348	6.2	469	50	22	834	280	8460	17	3480
		2.2	186	9	84	724	8.4	235	90	22	797	360	8370	15	3670
	200	2.0	124	8	13	300	<1.0	339	20	9	885	330	12800	14	4240
		2.0	124	8	12	221	<1.0	111	80	9	810	320	12200	13	4110
	300	1.2	166	7	14	235	<1.0	206	<20	12	1000	300	9000	14	3800
		1.4	166	7	26	403	0.6	274	<20	10	840	300	8190	14	3610
Control	1	2.0	270	9	90	715	14	300	30	110	1970	270	2460	28	3100
		0.9	227	4	26	440	13	300	140	80	2060	210	3600	16	3300
	3	1.8	186	13	27	697	26	300	80	83	1690	170	2800	7	3180
		1.7	186	10	46	781	17	346	570	73	1590	200	2790	19	3110
	10	1.7	124	27	47	729	--	267	170	120	1310	300	2780	5	3120
		2.1	103	26	--	>706	29	213	70	110	1290	130	2910	5	3120
	30	1.0	124	20	3	380	--	241	<20	74	1100	160	2950	3	2810
		3.1	145	27	--	>257	31	261	<20	160	1110	210	2860	5	3180
	100	1.4	124	27	39	338	29	202	50	12	651	200	6000	66	3750
		2.1	124	27	75	296	16	241	100	16	847	220	4530	50	3760
	200	2.2	82	--	20	137	10	130	420	18	670	260	10000	108	3770
		1.7	145	27	51	200	2.5	163	130	29	627	150	12600	238	3390
	300	1.1	103	27	39	218	--	273	190	18	822	170	10500	100	3400
		1.5	145	12	87	314	<1.0	241	<20	41	709	240	13600	98	3780

(continued)

TABLE D-15.(continued)

Site	Depth	Mg				CEC	Ag		Ba	Cd		Cr		Cu		Mn	
	(cm)	T	AE	WE	EX		T	AE	T	T	AE	T	AE	T	AE	T	AE
Test	1	18000	1340	77	592	26.1	<20	<1.0	750	6	1.8	174	4.3	52	7.0	486	198
		16000	1370	78	735	32.9	<20	<1.0	440	6	1.9	156	3.9	32	5.5	590	182
	3	9800	2200	84	654	26.1	<20	<1.0	340	<5	1.9	170	5.0	32	6.8	568	196
		10800	2110	86	655	27.7	<20	<1.0	320	<5	1.9	162	4.3	30	6.3	528	196
	10	11000	1730	67	652	27.7	<20	<1.0	330	<5	1.9	126	4.6	24	6.3	496	190
		13600	1730	72	678	31.0	<20	<1.0	410	6	2.0	136	4.3	30	6.1	514	196
	30	16000	1990	25	688	24.8	<20	<1.0	600	<5	1.7	144	3.6	24	5.1	540	148
		23000	1950	31	619	22.8	<20	<1.0	790	<5	2.0	102	3.8	22	5.5	510	157
	100	15000	1880	27	1050	36.5	<20	<1.0	150	<5	2.0	190	3.4	26	3.6	464	127
		28400	1800	16	1130	36.8	<20	<1.0	640	<5	2.4	126	3.2	32	3.7	606	142
	200	20800	1940	16	1000	26.1	<20	<1.0	680	6	2.0	178	3.2	36	2.0	530	134
		32600	1810	14	1090	31.3	<20	<1.0	730	<5	1.8	232	2.0	30	1.3	590	123
	300	24000	2050	22	1600	32.6	<20	<1.0	680	<5	1.4	246	5.4	32	2.4	508	130
		18800	1820	22	1070	25.4	<20	<1.0	450	6	1.6	224	3.4	38	2.0	530	132
Control	1	12400	1560	65	904	24.8	<20	<1.0	840	<5	2.0	126	3.6	44	8.9	478	168
		11200	1060	30	1130	26.1	<20	<1.0	820	<5	1.7	152	3.4	46	6.6	468	168
	3	12200	1260	10	937	31.0	<20	<1.0	820	<5	1.5	260	3.4	41	6.4	470	152
		11200	1390	25	938	30.0	<20	<1.0	740	<5	1.5	132	3.2	48	6.9	504	152
	10	9800	1080	10	818	24.5	<20	<1.0	820	<5	1.5	130	3.2	46	6.9	470	138
		10800	1270	9	991	24.5	<20	<1.0	830	<5	1.5	144	4.0	48	6.7	470	126
	30	11000	1230	8	742	17.9	<20	<1.0	810	<5	1.4	112	2.0	48	6.3	476	88
		10800	1450	16	1020	24.8	<20	<1.0	840	<5	1.4	174	3.9	36	5.6	446	108
	100	14800	1230	45	799	18.6	<20	<1.0	850	<5	1.2	208	4.6	34	5.3	472	98
		10800	1250	28	1200	20.5	<20	<1.0	790	6	1.1	170	5.8	38	5.1	526	93
	200	16200	1210	66	581	25.4	<20	<1.0	810	<5	1.4	126	4.3	32	4.3	514	113
		15000	1140	43	432	20.5	<20	<1.0	920	<5	1.2	148	4.0	26	3.7	478	117
	300	15400	1360	50	272	17.3	<20	<1.0	810	<5	1.4	180	4.1	30	4.4	492	112
		20800	1370	24	1130	29.7	<20	<1.0	720	<5	1.8	1272	3.4	38	3.6	510	100

(continued)

TABLE D-15 (continued)

Site	Depth (cm)	Mo	Ni		Pb		Zn		As		Hg		Se	
		T	T	AE	T	AE	T	AE	T	AE	T	AE	T	AE
Test	1	<20	79	7.9	42	6.8	132	22.5	< 2.0	0.7	<0.5	< 0.05	16	<0.1
		<20	82	8.0	38	6.2	96	17.3	< 2.0	0.5	<0.5	< 0.05	8.2	<0.1
	3	<20	84	8.3	46	6.5	92	22.1	< 2.0	0.8	<0.5	< 0.05	--	<0.1
		<20	78	8.2	16	6.6	92	21.7	< 2.0	0.6	<0.5	< 0.05	7.4	<0.1
	10	<20	72	7.7	36	6.5	102	21.1	< 2.0	0.6	<0.5	< 0.05	16	<0.1
		<20	80	8.4	36	7.9	97	23.1	3.3	0.7	<0.5	< 0.05	--	<0.1
	30	<20	78	8.2	40	4.7	112	23.8	2.0	0.8	<0.5	< 0.05	--	<0.1
		<20	76	9.8	50	6.6	84	19.4	< 2.0	0.8	0.6	< 0.05	8.9	<0.1
	100	<20	96	7.2	20	4.3	66	10.1	< 2.0	0.5	<0.5	< 0.05	9.6	<0.1
		<20	78	8.0	24	5.2	72	10.0	< 2.0	0.6	<0.5	< 0.05	38	<0.1
	200	<20	64	7.7	26	4.8	86	9.0	< 2.0	0.4	<0.5	< 0.05	13	<0.1
		<20	78	6.7	24	4.0	88	5.5	< 2.0	0.4	<0.5	< 0.05	36	<0.1
	300	<20	66	7.9	32	3.6	84	7.5	< 2.0	0.6	<0.5	< 0.05	12	<0.1
		<20	62	7.2	42	3.4	98	8.9	< 2.0	0.4	<0.5	< 0.05	16	<0.1
Control	1	<20	74	9.5	170	43.8	96	8.7	< 2.0	1.7	<0.5	< 0.05	--	<0.1
		<20	68	9.4	154	43.0	100	11.5	< 2.0	2.0	<0.5	< 0.05	27	<0.1
	3	42	AIP	10.7	--	42.3	114	8.9	10.0	1.8	<0.5	< 0.05	--	<0.1
		<20	78	9.5	180	42.8	102	8.9	10.2	1.7	<0.5	< 0.05	24	<0.1
	10	<20	78	9.5	186	45.2	70	11.5	12.9	1.7	<0.5	< 0.05	42	<0.1
		<20	82	10.4	126	25.9	70	11.4	5.8	1.9	<0.5	< 0.05	2.9	<0.1
	30	<20	70	9.1	70	9.3	68	11.0	6.9	1.0	<0.5	< 0.05	19	<0.1
		<20	66	10.5	58	9.5	106	8.0	7.1	1.1	<0.5	< 0.05	15	<0.1
	100	<20	70	8.3	50	5.3	108	10.2	5.2	0.3	<0.5	< 0.05	31	<0.1
		30	62	8.2	54	6.3	102	9.1	5.0	0.3	<0.5	< 0.05	12	<0.1
	200	<20	66	6.1	22	4.7	102	10.8	2.6	0.5	<0.5	< 0.05	13	<0.1
		<20	64	5.3	26	5.5	94	7.0	2.5	0.3	<0.5	< 0.05	44	<0.1
	300	<20	66	5.9	24	4.2	82	8.3	7.7	0.5	<0.5	< 0.05	15	<0.1
		<20	80	6.8	36	5.7	96	5.8	< 2.0	0.4	<0.5	< 0.05	19	<0.1

(continued)

TABLE D-15 (continued)

[a] All values in mg/kg unless noted.
[b] NO_3-N + KjN.
[c] WE = Water extractible.
[d] T = Total.
[e] AE = Acid extractible.
[f] EX= Exchangeable.
[g] meg/100 gm.

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APPENDIX E

STATISTICAL TABLES

TABLE E-1.STATISTICAL COMPARISON BETWEEN TEST EFFLUENT AND CONTROL IRRIGATION WATER

C.T.EFFLUENT	* MPN/100 ml * TC	FC	TDS	B	Constituent(mg/l) Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	25	25	21	25	23	18	14	10	12	18	20	25	20
MEAN	57058.80	221.80	995.43	0.85	165.77	1.60	4.63	15.04	34.67	11.81	194.15	16.90	211.91
STD. DEV.	2.44E+05	710.48	130.55	0.36	44.57	0.55	3.59	7.20	10.31	3.14	51.23	3.42	80.26

C.T.EFFLUENT	Ca	Mg	Ba	Cd	Constituent(mg/l) Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	21	24	22	25	24	24	17	23	23	25	22	22
MEAN	54.71	33.73	0.08	0.02	0.02	0.06	0.11	0.10	0.05	0.05	0.01	0.01
STD. DEV.	42.67	15.07	0.07	0.01	0.02	0.03	0.02	0.12	0.03	0.03	0.01	0.02

C.C.IRRIGATION	* MPN/100 ml * TC	FC	TDS	B	Constituent(mg/l) Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	18	18	15	12	11	11	11	10	10	12	10	12	11
MEAN	0.00	0.00	732.67	0.23	72.94	0.61	2.10	3.47	3.75	0.47	226.60	4.60	68.36
STD. DEV.	0.00	0.00	119.84	0.07	12.11	0.26	2.31	4.11	2.77	0.41	23.51	0.91	26.43

C.C.IRRIGATION	Ca	Mg	Ba	Cd	Constituent(mg/l) Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	10	12	12	12	12	12	13	11	12	12	10	10
MEAN	49.59	40.11	0.17	0.01	0.03	0.13	0.10	0.05	0.08	0.07	0.01	0.01
STD. DEV.	7.70	16.56	0.16	0.01	0.02	0.05	0.01	0.03	0.07	0.04	0.01	0.00

*LEVELS OF CONFIDENCE OF DIFFERENCE ($)	TC	FC	TDS	B	Cl	/ PAGE 1 7/5/78 F	NO3	TN	TOC	PO4	SO4	K	Na
H-TEST	75.00	88.00	99.00	99.00	99.00	99.00	96.00	99 00	99 00	99 00	98.00	99.00	99.00
CHI-SQUARE			$80	99.00	99.00	99.00	99 00	99.00	99 00	99 00	99.00	99.00	99.00
T-TEST	$60	$80	99.00	99.00	99 00	99.00	90.00	99 00	99 00	99 00	90 00	99.00	99 00

*LEVELS OF CONFIDENCE OF DIFFERENCE ($)	Ca	Mg	Ba	Cd	Cr	/ PAGE 2 7/5/78 Cu	Mo	Ni	Pb	Zn	As	Se
H-TEST	$75	$75	92.00	$75	$75	99.00	83.00	95.00	75.00	93 00	83.00	$75
CHI-SQUARE	99.00	$50	99.00	99.00	90.00	99.00	99.00	99.00	99.00	95.00	90.00	
T-TEST	$80	$60	95.00	$80	$80	99.00	$80	80.00	80.00	90.00	80.00	$80

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TABLE E-2. STATISTICAL COMPARISON BETWEEN TEST AND CONTROL LEACHATE AT 50 CM

CTL-50	* MPN/100 ml * TC	FC	Constituent(mg/l) TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	22	22	15	13	10	11	8	6	11	8	10	13	13
MEAN	41.82	0.91	1741.07	0.89	246.70	0.75	34.55	36.57	26.11	4.78	267.10	26.87	246.62
STD. DEV.	162.05	4.17	456.28	0.44	56.16	0.38	13.99	15.58	15.91	2.71	59.43	7.47	79.53

CTL-50	Constituent(mg/l) Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	12	11	13	14	14	14	12	13	14	13	8	12
MEAN	112.47	155.36	0.19	0.02	0.05	0.19	0.12	0.10	0.12	0.41	0.01	0.01
STD. DEV.	79.55	180.33	0.17	0.01	0.05	0.15	0.06	0.08	0.08	0.35	0.00	0.00

CCL-50	* MPN/100 ml * TC	FC	Constituent(mg/l) TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	19	18	5	10	10	8	7	6	6	9	9	11	11
MEAN	4.00	0.00	1996.40	0.74	216.80	1.08	28.21	27.48	27.25	3.81	433.67	15.36	217.00
STD. DEV.	11.77	0.00	221.82	0.35	67.65	0.37	16.65	20.11	12.25	2.74	117.83	6.15	55.71

CCL-50	Constituent(mg/l) Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	8	10	10	12	12	11	11	11	12	8	9	11
MEAN	93.88	127.06	0.11	0.03	0.02	0.12	0.13	0.07	0.07	0.43	0.02	0.02
STD. DEV.	55.75	78.53	0.08	0.02	0.01	0.06	0.09	0.03	0.02	0.16	0.01	0.02

*LEVELS OF CONFIDENCE OF DIFFERENCE ($) / PAGE 1 7/5/78

	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
H-TEST	$75	$75	90.00	$75	$75	94.00	$75	$75	$75	$75	99.00	99.00	$75
CHI-SQUARE	99.00		99.00	80.00	$80	$80	$80	$80	90.00	$80	95.00	80.00	99.00
T-TEST	$80	$80	$80	$80	$80	90.00	$80	$80	$80	$80	99.00	99.00	$80

*LEVELS OF CONFIDENCE OF DIFFERENCE ($) / PAGE 2 7/5/78

	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
H-TEST	$75	$75	85.00	84.00	95.00	88.00	$75	86.00	94.00	$75	81.00	78.00
CHI-SQUARE	95.00	99.00	99.00	99.00	99.00	99.00	80.00	99.00	99.00	99.00	99.00	99.00
T-TEST	$80	$80	$80	80.00	90.00	80.00	$80	80.00	90.00	$80	$80	$80

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TABLE E-3. STATISTICAL COMPARISON BETWEEN TEST AND CONTROL LEACHATE AT 100 CM

CTL-100	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	22	21	15	15	11	11	10	7	13	11	11	14	14
MEAN	177.82	0.95	1920.13	1.02	227.47	0.66	53.01	47.49	19.08	2.90	284.09	16.09	266.60
STD. DEV.	688.80	4.26	392.78	0.54	83.54	0.26	15.76	13.60	6.90	1.94	96.18	4.37	118.55

CTL-100	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	13	13	10	13	13	13	16	13	15	14	12	12
MEAN	73.91	120.52	0.23	0.02	0.02	0.14	0.16	0.07	0.09	0.25	0.01	0.01
STD. DEV.	24.73	71.96	0.14	0.02	0.02	0.08	0.10	0.04	0.05	0.24	0.00	0.00

CCL-100	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	22	21	12	12	10	11	6	5	9	9	9	11	8
MEAN	84.68	3.81	2505.42	0.65	288.42	0.91	32.48	34.14	29.39	3.03	881.44	12.44	284.00
STD. DEV.	270.00	7.85	536.65	0.27	42.32	0.38	20.09	21.84	18.74	1.68	315.32	2.95	107.62

CCL-100	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	9	9	7	12	11	11	12	9	12	11	9	10
MEAN	195.03	134.71	0.22	0.02	0.05	0.13	0.10	0.05	0.13	0.59	0.01	0.01
STD. DEV.	69.98	69.91	0.18	0.01	0.03	0.06	0.01	0.04	0.04	0.33	0.01	0.00

*LEVELS OF CONFIDENCE OF DIFFERENCE ($) / PAGE 1 7/5/78

	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
H-TEST	$75	85.00	99.00	97.00	96.00	93.00	96.00	77.00	88.00	$75	99.00	98.00	$75
CHI-SQUARE	99.00	99.00	$80	99.00	99.00	$80	$80	$80	99.00	$80	99.00	99.00	$80
T-TEST	$80	80.00	99.00	95.00	90.00	90.00	90.00	$80	90.00	$80	99.00	95.00	$80

*LEVELS OF CONFIDENCE OF DIFFERENCE ($) / PAGE 2 7/5/78

	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
H-TEST	99.00	$75	$75	$75	94.00	$75	97.00	82.00	93.00	99.00	$75	$75
CHI-SQUARE	99.00	$80	$80	99.00	90.00	80.00	99.00	$80	$80	$80	90.00	
T-TEST	99.00	$80	$80	$80	90.00	$80	90.00	$80	90.00	99.00	$80	$80

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TABLE E-4. MEAN AND STANDARD DEVIATION OF TEST LEACHATE AT 300 CM

CTL-300	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	14	14	10	12	10	7	8	6	8	9	10	12	11
MEAN	14.29	5.00	1719.20	1.12	220.80	1.04	62.15	63.63	11.19	0.20	246.00	11.61	300.09
STD. DEV.	51.51	18.03	456.23	0.40	31.88	0.56	22.31	20.05	8.35	0.18	64.29	5.06	95.66

CTL-300	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	9	9	10	11	12	12	9	12	12	12	9	11
MEAN	82.81	173.80	0.09	0.01	0.05	0.10	0.32	0.10	0.05	0.09	0.01	0.01
STD. DEV.	14.21	90.26	0.06	0.01	0.05	0.08	0.11	0.11	0.03	0.07	0.00	0.00

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TABLE E-5. STATISTICAL COMPARISON BETWEEN TOP LEVELS OF TEST WELLS 1 AND 2.

CTW-2-T	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	20	20	19	12	14	10	10	10	9	9	10	11	11
MEAN	820.00	0.00	3232.00	0.67	462.86	1.27	50.87	51.93	11.94	0.39	930.80	5.21	257.87
STD. DEV.	3482.88	0.00	362.81	0.30	68.23	0.38	5.92	6.77	10.39	0.36	122.05	0.56	60.21

CTW-2-T	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	10	11	10	13	10	11	11	10	11	11	9	9
MEAN	204.38	166.88	0.12	0.02	0.04	0.07	0.09	0.10	0.10	0.06	0.01	0.01
STD. DEV.	52.12	64.54	0.07	0.01	0.03	0.03	0.03	0.05	0.05	0.02	0.00	0.00

CTW-1-T	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	18	18	19	12	15	11	10	9	12	12	12	12	12
MEAN	0.00	0.00	3004.16	0.88	261.87	1.02	39.90	41.28	8.96	0.40	1378.83	11.63	288.41
STD. DEV.	0.00	0.00	458.29	0.41	20.24	0.39	5.22	5.95	6.13	0.50	328.32	2.87	76.74

CTW-1-T	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	9	8	10	15	12	12	11	10	13	13	9	10
MEAN	178.40	72.62	0.13	0.02	0.09	0.04	0.17	0.10	0.09	0.05	0.01	0.01
STD. DEV.	63.06	32.02	0.10	0.01	0.08	0.02	0.09	0.06	0.04	0.02	0.00	0.00

*LEVELS OF CONFIDENCE OF DIFFERENCE ($) / PAGE 1 7/5/78

	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
H-TEST	$75		90.00	63.00	99.00	85.00	99.00	99.00	$75	$75	99.00	99.00	$75
CHI-SQUARE			$80	$80	99.00	$80	$80	$80	99.00	80.00	99.00	99.00	$80
T-TEST	$80		80.00	60.00	99.00	80.00	95.00	99.00	$80	$80	99.00	99.00	$80

*LEVELS OF CONFIDENCE OF DIFFERENCE ($) / PAGE 2 7/5/78

	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
H-TEST	$75	99.00	$75	$75	96.00	97.00	98.00	$75	$75	$75	$75	
CHI-SQUARE	$80	99.00	90.00	$80	99.00	99.00	99.00	$80	90.00	$80	99.00	
T-TEST	$80	99.00	$80	$80	90.00	95.00	95.00	$80	$80	$80	$80	

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TABLE E-6. STATISTICAL COMPARISON BETWEEN BOTTOM LEVELS OF TEST WELLS 1 AND 2

CTW-2-B	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	17	17	18	10	9	9	9	9	9	10	9	10	10
MEAN	5454.12	0.00	3330.50	0.81	529.56	1.11	62.62	63.20	14.68	0.66	923.44	5.83	257.40
STD. DEV.	21636.68	0.00	364.36	0.25	46.85	0.34	6.56	6.53	12.50	0.59	89.12	0.61	59.38

CTW-2-B	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	9	10	9	10	9	8	9	9	10	10	9	9
MEAN	199.00	175.69	0.12	0.02	0.04	0.06	0.11	0.11	0.12	0.05	0.01	0.01
STD. DEV.	38.84	67.61	0.06	0.01	0.03	0.03	0.03	0.07	0.05	0.02	0.00	0.00

CTW-1-B	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	17	17	17	10	11	11	9	9	8	11	8	10	11
MEAN	0.00	0.00	3523.59	1.14	296.57	1.27	38.22	38.64	10.29	0.28	1386.25	8.59	298.85
STD. DEV.	0.00	0.00	395.28	0.43	43.64	0.42	6.73	6.70	4.14	0.30	263.98	4.97	82.51

CTW-1-B	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	9	8	9	11	10	9	10	8	11	11	9	9
MEAN	165.67	242.86	0.13	0.03	0.10	0.05	0.19	0.10	0.09	0.07	0.01	0.01
STD. DEV.	29.22	105.95	0.08	0.02	0.12	0.02	0.08	0.07	0.06	0.04	0.00	0.00

*LEVELS OF CONFIDENCE OF DIFFERENCE ($)						/ PAGE 1 7/5/78							
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
H-TEST	$75		86.00	96.00	99.00	$75	99.00	99.00	$75	94.00	99.00	91.00	81.00
CHI-SQUARE			$80	80.00	$80	$80	$80	$80	99.00	99.00	99.00	99.00	$80
T-TEST	$80		80.00	90.00	99.00	$80	99.00	99.00	$80	90.00	99.00	80.00	$80

*LEVELS OF CONFIDENCE OF DIFFERENCE ($)					/ PAGE 2 7/5/78							
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
H-TEST	96.00	88.00	$75	$75	89.00	$75	99.00	$75	$75	86.00	$75	
CHI-SQUARE	80.00	80.00	$80	$80	99.00	80.00	95.00	$80	$80	90.00	99.00	
T-TEST	90.00	80.00	$80	$80	80.00	$80	95.00	$80	$80	80.00	$80	

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TABLE E-7. STATISTICAL COMPARISON BETWEEN TOP LEVELS OF TEST WELLS 1 AND 3

CTW-3-T	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	19	19	18	12	13	10	10	10	10	11	11	11	11
MEAN	331.05	0.00	3916.22	0.99	358.03	1.23	52.84	53.90	12.97	0.47	1643.73	4.65	301.65
STD. DEV.	1197.02	0.00	312.86	0.41	74.69	0.42	9.40	8.89	8.52	0.47	358.92	1.04	73.45

CTW-3-T	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	9	11	10	13	10	11	10	10	11	11	10	9
MEAN	198.46	280.16	0.14	0.02	0.07	0.06	0.22	0.10	0.11	0.05	0.01	0.01
STD. DEV.	40.30	136.09	0.07	0.02	0.08	0.03	0.12	0.06	0.08	0.02	0.00	0.00

CTW-1-T	* MPN/100 ml *		Constituent(mg/l)										
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	18	18	19	12	15	11	10	9	12	12	12	12	12
MEAN	0.00	0.00	3004.16	0.88	261.87	1.02	39.90	41.28	8.96	0.40	1378.83	11.63	288.41
STD. DEV.	0.00	0.00	458.29	0.41	20.24	0.39	5.22	5.95	6.13	0.50	328.32	2.87	76.74

CTW-1-T	Constituent(mg/l)											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	9	8	10	15	12	12	11	10	13	13	9	10
MEAN	178.40	72.62	0.13	0.02	0.09	0.04	0.17	0.10	0.09	0.05	0.01	0.01
STD. DEV.	63.06	32.02	0.10	0.01	0.08	0.02	0.09	0.06	0.04	0.02	0.00	0.00

*LEVELS OF CONFIDENCE OF DIFFERENCE ($)	/ PAGE 1 7/5/78												
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
H-TEST	77.00		99.00	$75	99.00	75.00	99.00	99.00	78.00	$75	93.00	99.00	$75
CHI-SQUARE			90.00	$80	99.00	$80	99.00	99.00	95.00	$80	$80	99.00	$80
T-TEST	$80		99.00	$80	99.00	$80	99.00	99.00	$80	$80	90.00	99.00	$80

*LEVELS OF CONFIDENCE OF DIFFERENCE ($)	/ PAGE 2 7/5/78											
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
H-TEST	$75	99.00	$75	$75	$75	85.00	76.00	$75	$75	$75	$75	
CHI-SQUARE	80.00	99.00	80.00	99.00	$80	95.00	80.00	$80	99.00	80.00	90.00	
T-TEST	$80	99.00	$80	$80	$80	80.00	$80	$80	$80	$80	$80	

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TABLE E-8. STATISTICAL COMPARISON BETWEEN BOTTOM LEVELS OF TEST WELLS 1 AND 3

CTW-3-B	* MPN/100 ml *				Constituent(mg/l)								
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	18	18	15	10	10	9	9	9	9	10	9	10	9
MEAN	412.22	1.11	4001.60	1.05	365.87	1.08	44.29	45.59	13 50	0.60	1586.11	5.19	294.00
STD. DEV.	871.33	4.58	247.80	0.38	25.51	0.47	7.60	7.98	10.94	0.60	262.19	1.14	73.97

CTW-3-B					Constituent(mg/l)							
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	8	9	9	10	8	9	9	9	10	10	9	9
MEAN	189.95	295.30	0.16	0.02	0.03	0.07	0.23	0.10	0.12	0.08	0.01	0.01
STD. DEV.	33.86	141.73	0.07	0.01	0.02	0.04	0.09	0.06	0.05	0.06	0.00	0.00

CTW-1-B	* MPN/100 ml *				Constituent(mg/l)								
	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
SAMPLES	17	17	17	10	11	11	9	9	8	11	8	10	11
MEAN	0.00	0.00	3523.59	1.14	296.57	1 27	39 22	38 64	10 29	0 28	1386 25	8.59	298 85
STD. DEV.	0.00	0.00	395.28	0.43	43 64	0.42	6.73	6.70	4 14	0.30	263 98	4.97	82.51

CTW-1-B					Constituent(mg/l)							
	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
SAMPLES	9	8	9	11	10	9	10	8	11	11	9	9
MEAN	165.67	242.86	0.13	0.03	0.10	0.05	0.19	0.10	0.09	0.07	0.01	0.01
STD. DEV.	29.22	105.95	0.08	0.02	0.12	0.02	0.08	0.07	0.06	0.04	0.00	0.00

*LEVELS OF CONFIDENCE OF DIFFERENCE ($) / PAGE 1 7/5/78

	TC	FC	TDS	B	Cl	F	NO3	TN	TOC	PO4	SO4	K	Na
H-TEST	95.00	$75	99.00	$75	99.00	$75	92.00	95.00	$75	88.00	86.00	96.00	$75
CHI-SQUARE			90.00	$80	80.00	$80	$80	$80	99.00	99.00	$80	99.00	$80
T-TEST	90.00	$80	99.00	$80	99.00	$80	80.00	90.00	$60	80.00	80.00	90.00	$80

*LEVELS OF CONFIDENCE OF DIFFERENCE ($) / PAGE 2 7/5/78

	Ca	Mg	Ba	Cd	Cr	Cu	Mo	Ni	Pb	Zn	As	Se
H-TEST	88.00	$75	$75	81.00	93 00	$75	75.00	$75	$75	$75	$75	
CHI-SQUARE	$80	80.00	$80	99.00	99.00	99 00	$80	$80	$80	95 00	99.00	
T-TEST	80.00	$80	$80	$80	80.00	$80	$80	$80	$80	$80	$80	

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APPENDIX F

GRAPHIC EVALUATION OF THE WATER ANALYSES

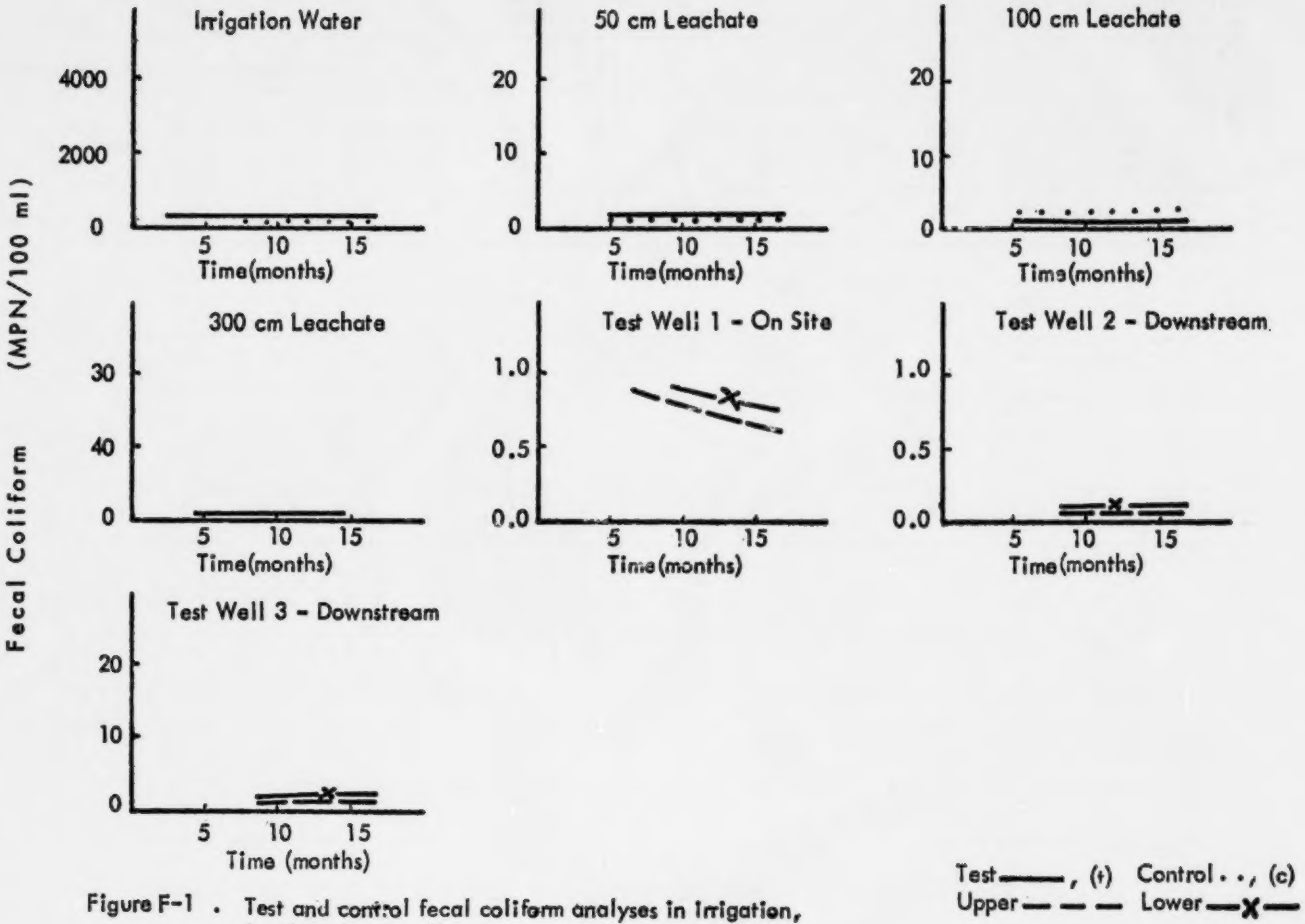


Figure F-1 . Test and control fecal coliform analyses in irrigation, leachate, and well water.

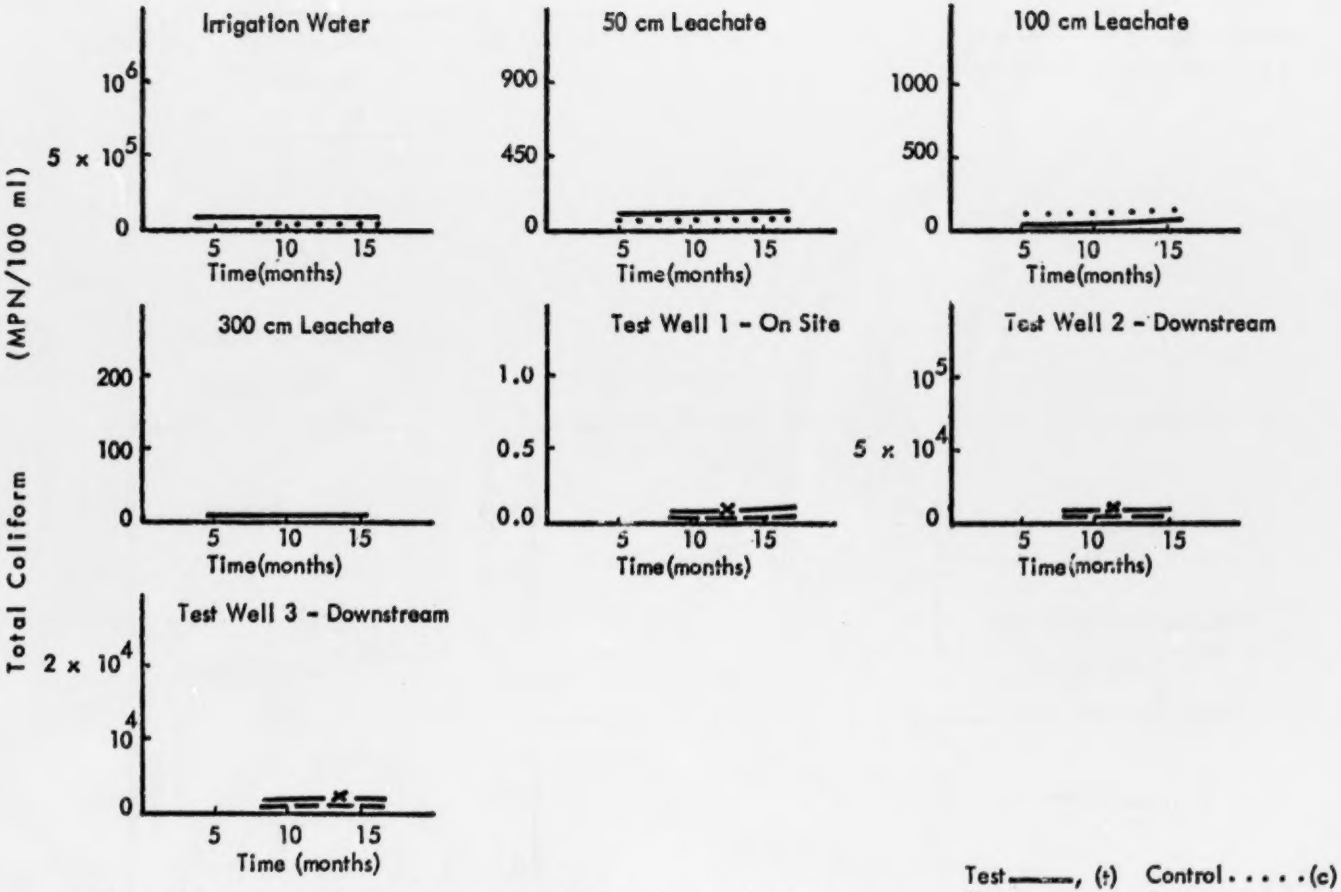


Figure F-2. Test and control site total coliform analyses in irrigation, leachate, and well water.

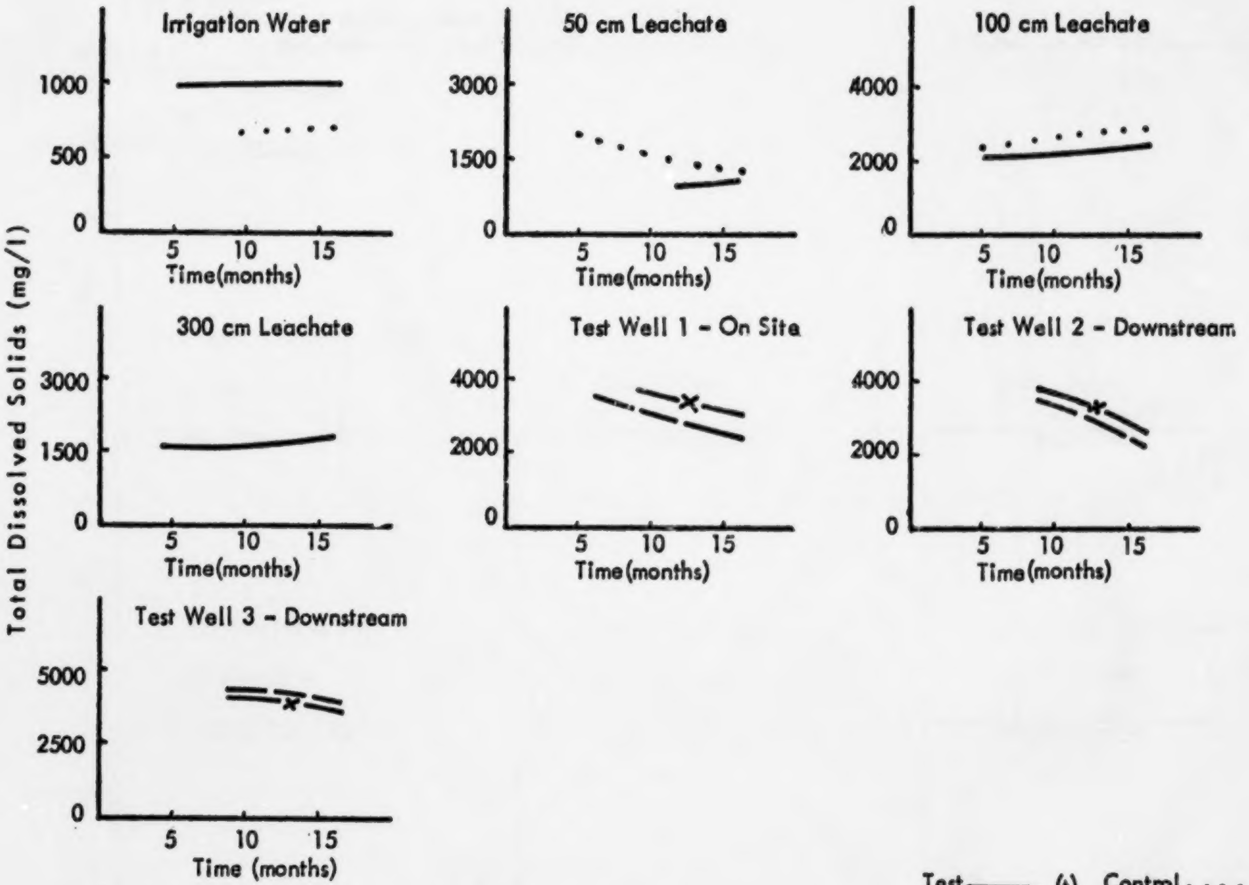


Figure F-3 . Test and control site total dissolved solid analyses in irrigation, leachate, and well water.

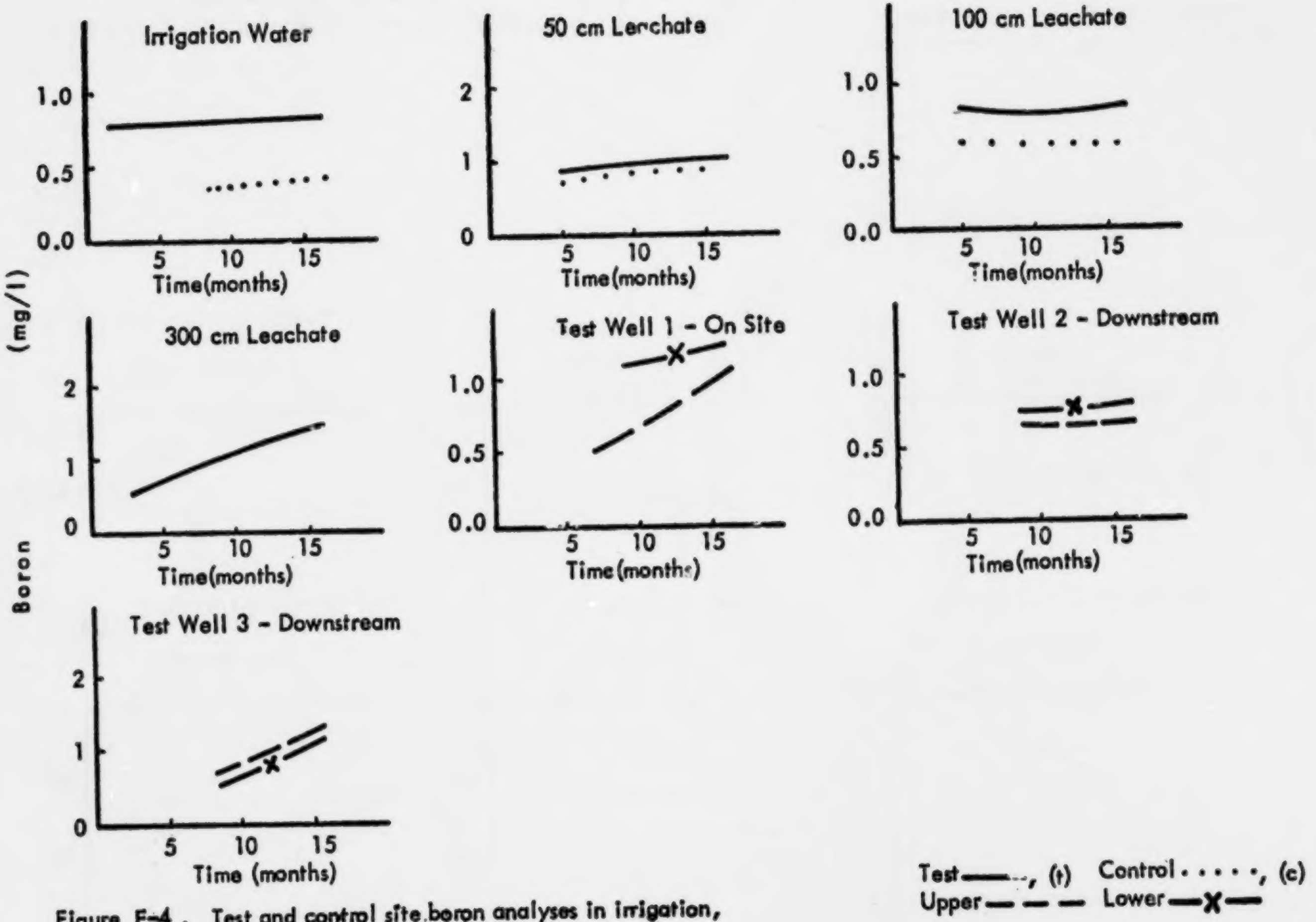


Figure F-4. Test and control site boron analyses in irrigation, leachate, and well water.

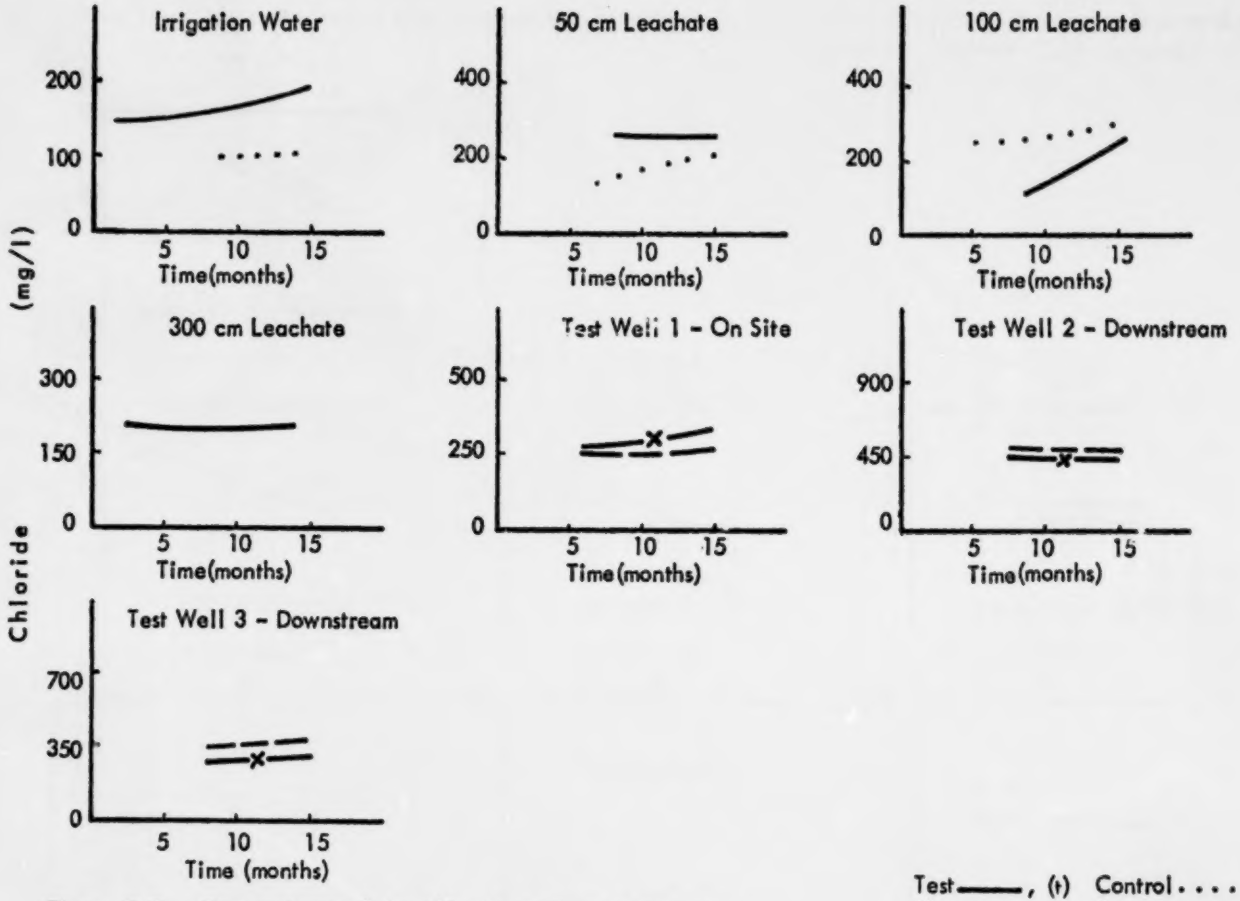


Figure F-5 . Test and control site chloride analyses in irrigation, leachate, and well water.

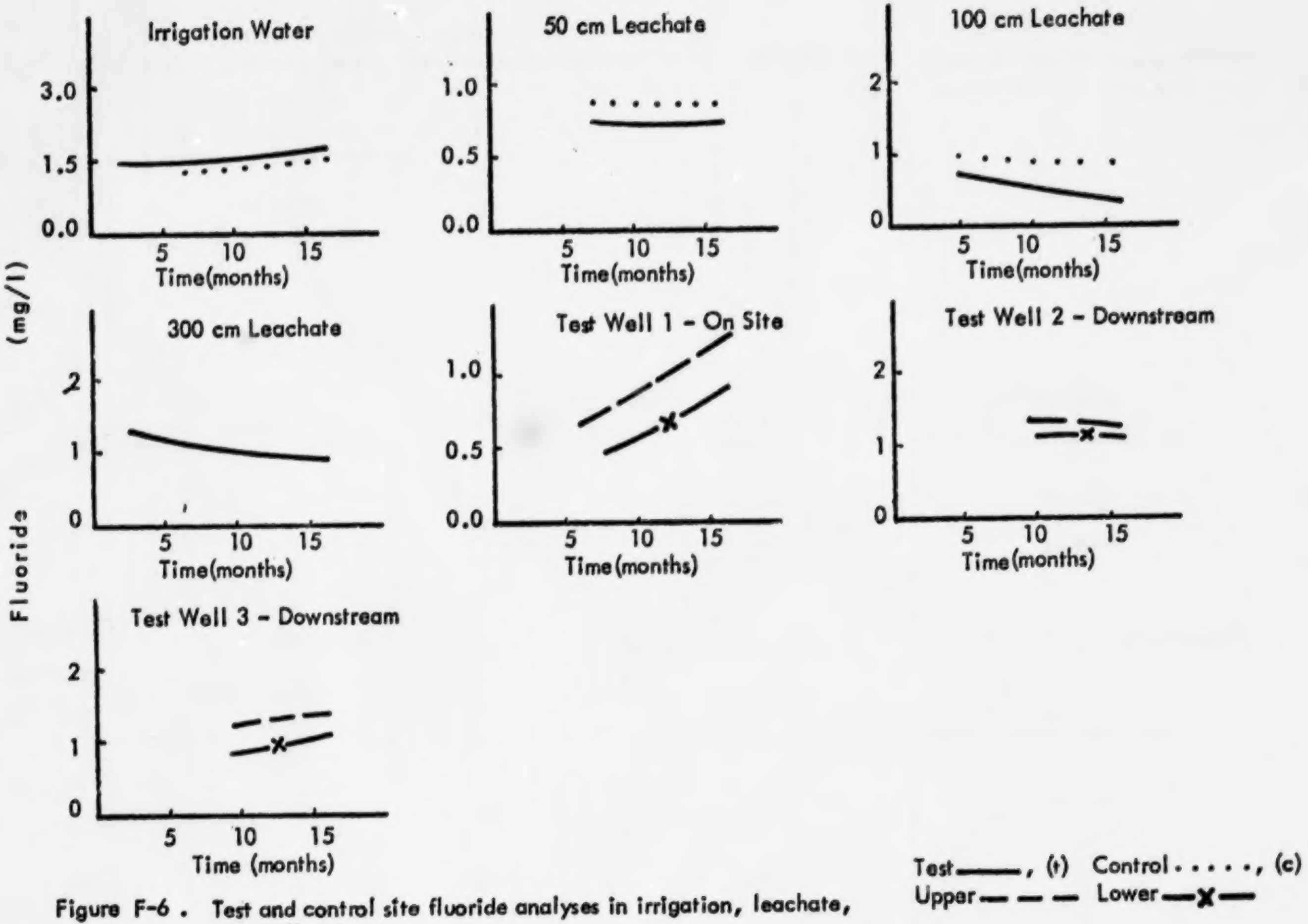


Figure F-6 . Test and control site fluoride analyses in irrigation, leachate, and well water.

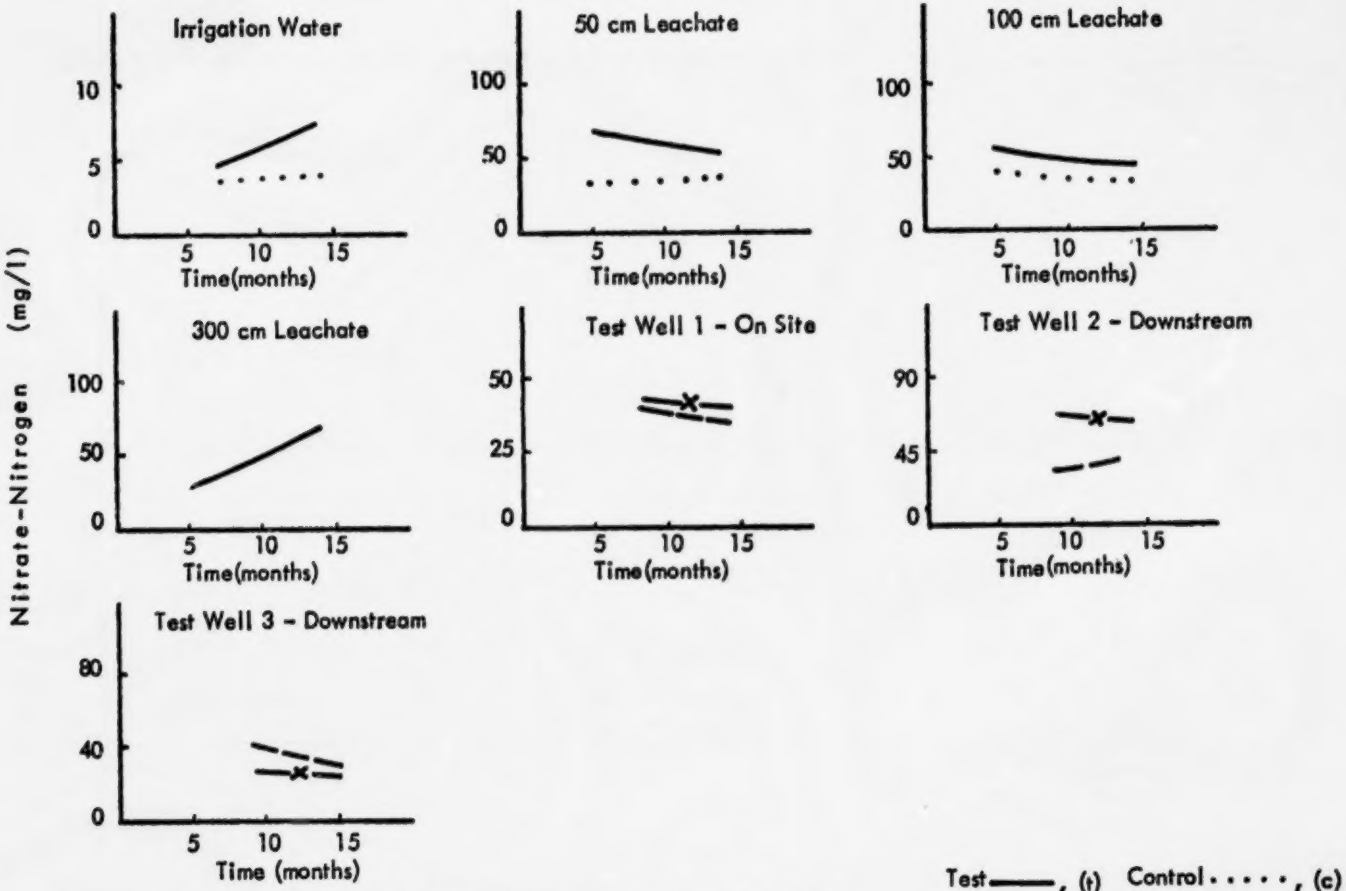


Figure F-7 Test and control site nitrate-nitrogen analyses in irrigation, leachate, and well water.

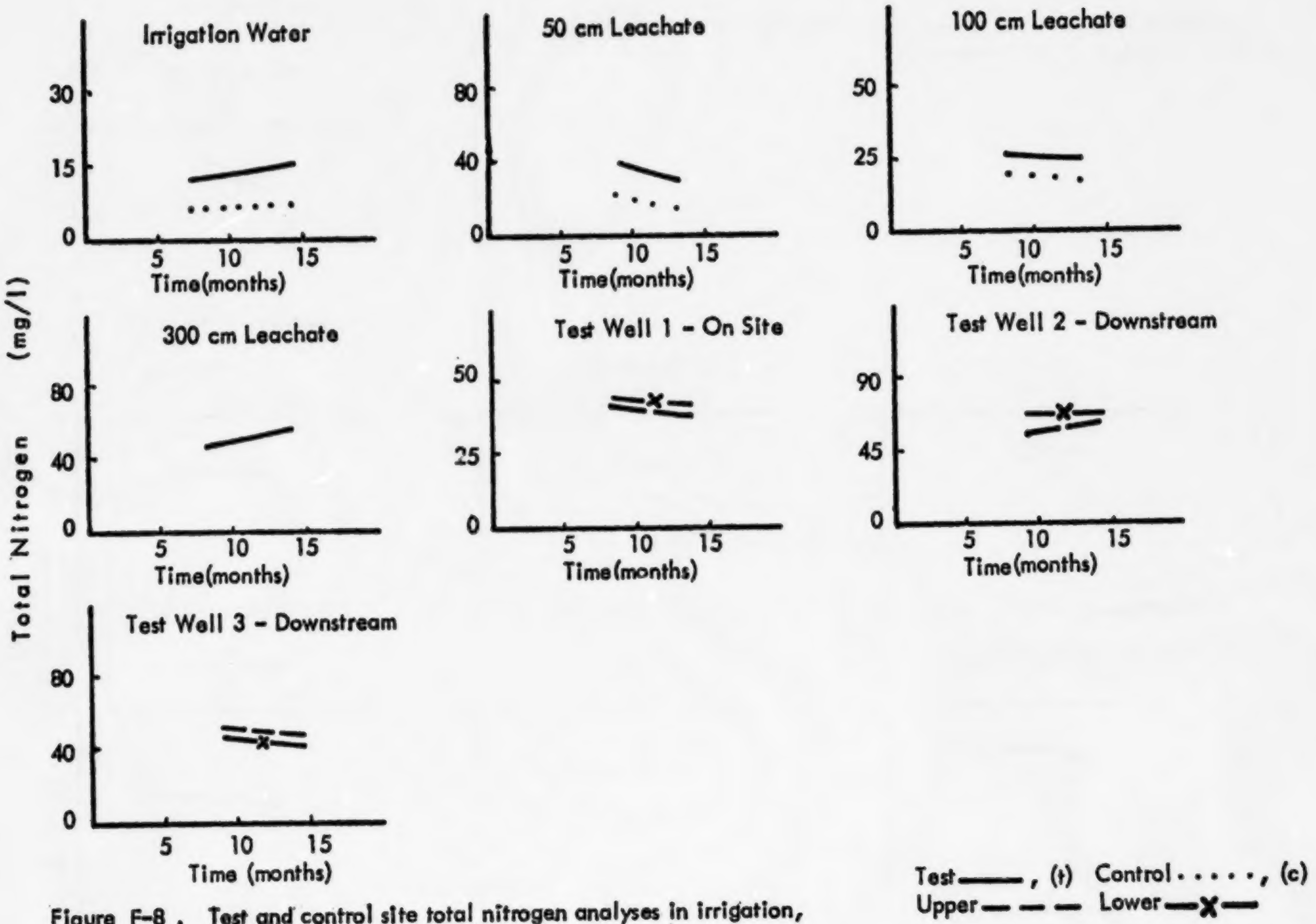


Figure F-8 . Test and control site total nitrogen analyses in irrigation, leachate, and well water.

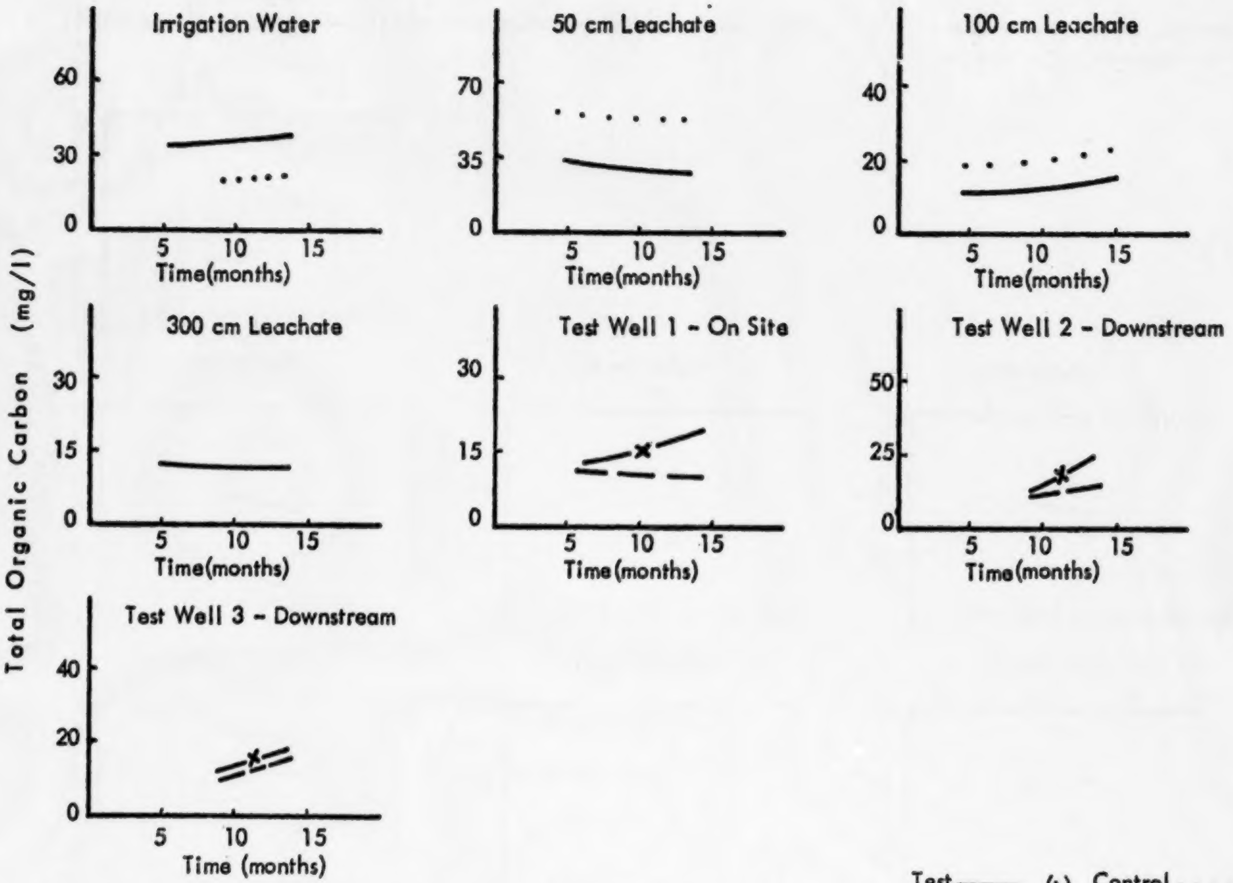


Figure F-9 . Test and control site total organic carbon analyses in irrigation, leachate, and well water.

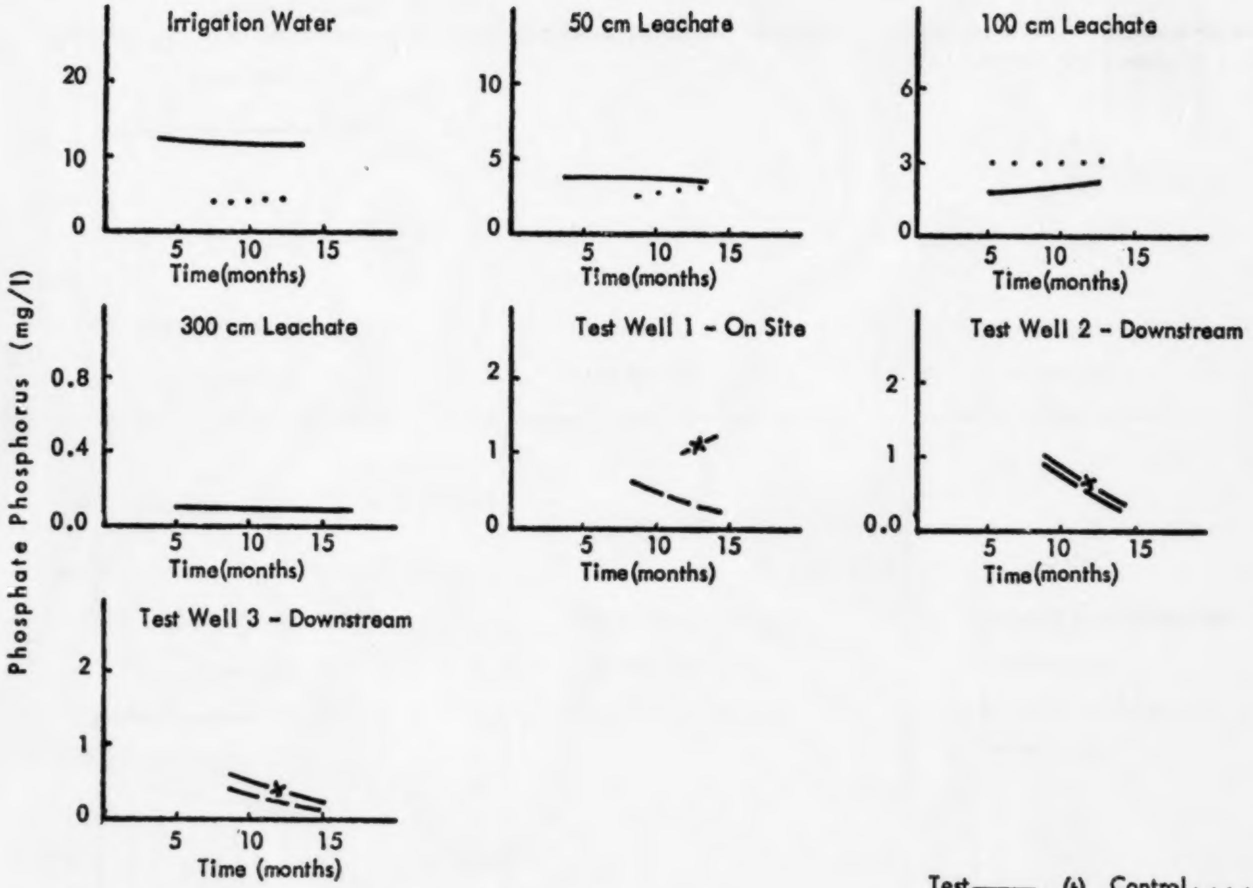


Figure F-10. Test and control site phosphate phosphorus analyses in irrigation, leachate, and well water.

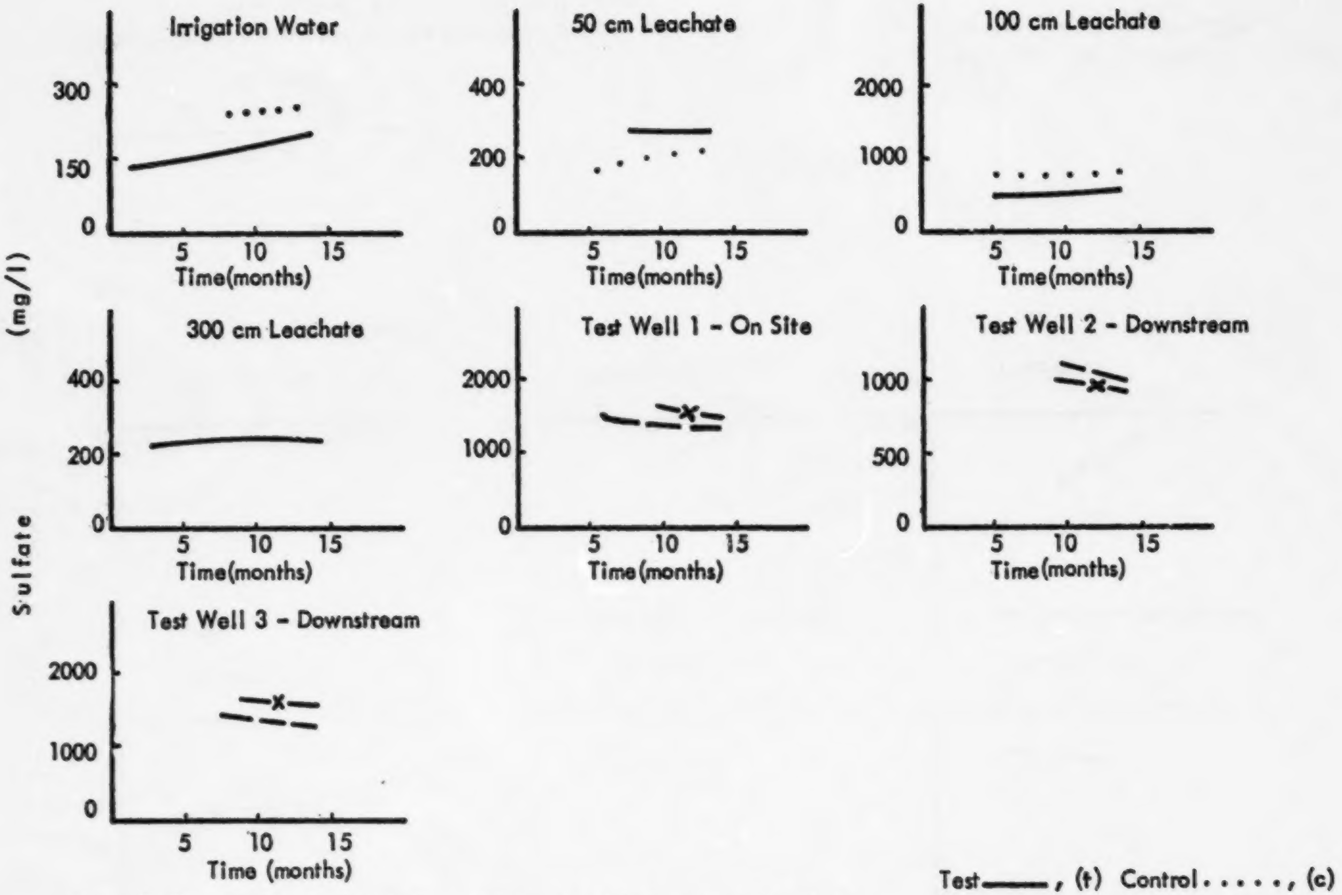


Figure F-11. Test and control site sulfate analyses in irrigation, leachate, and well water.

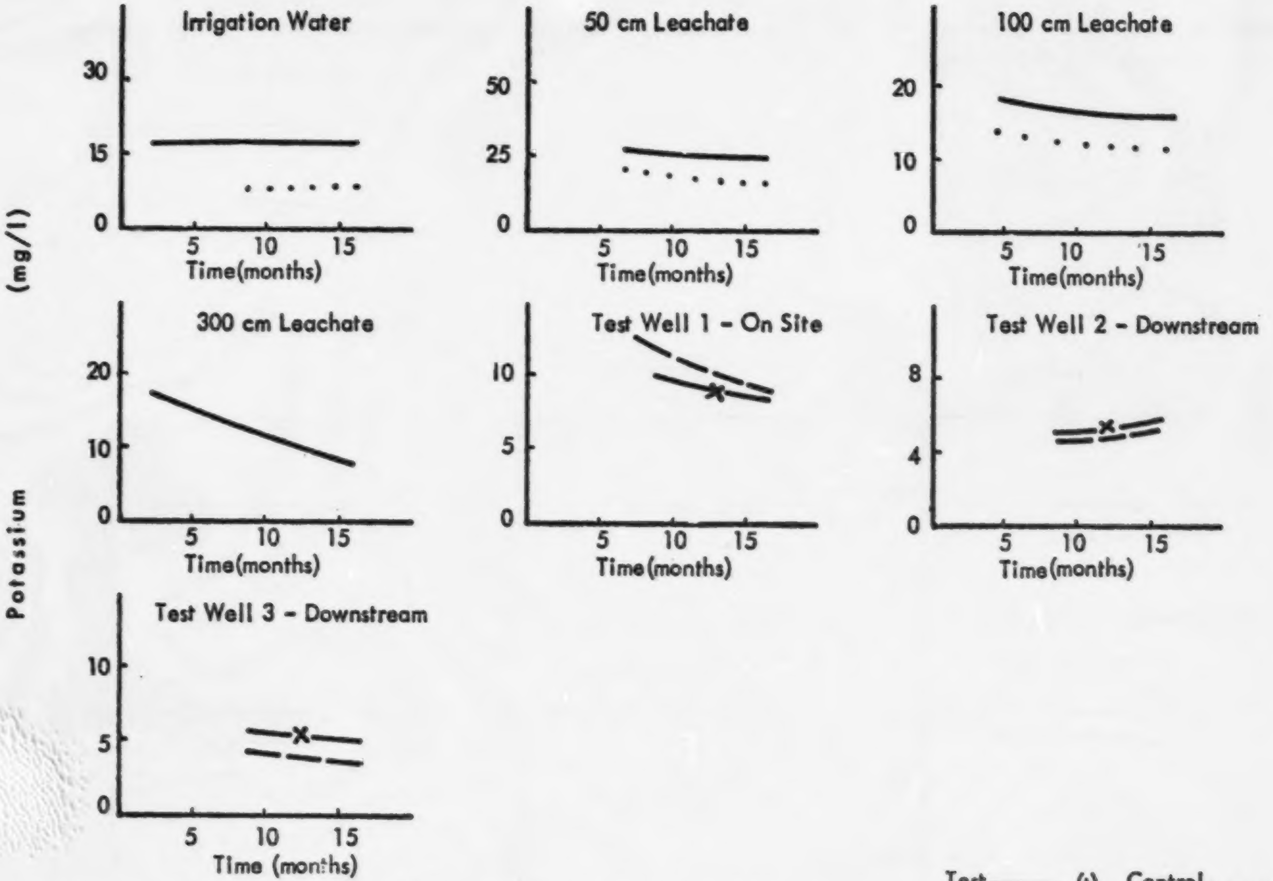


Figure F-12. Test and control site potassium analyses in irrigation, leachate, and well water.

Test ———, (t) Control · · · · ·, (c)
Upper — — — Lower —X—

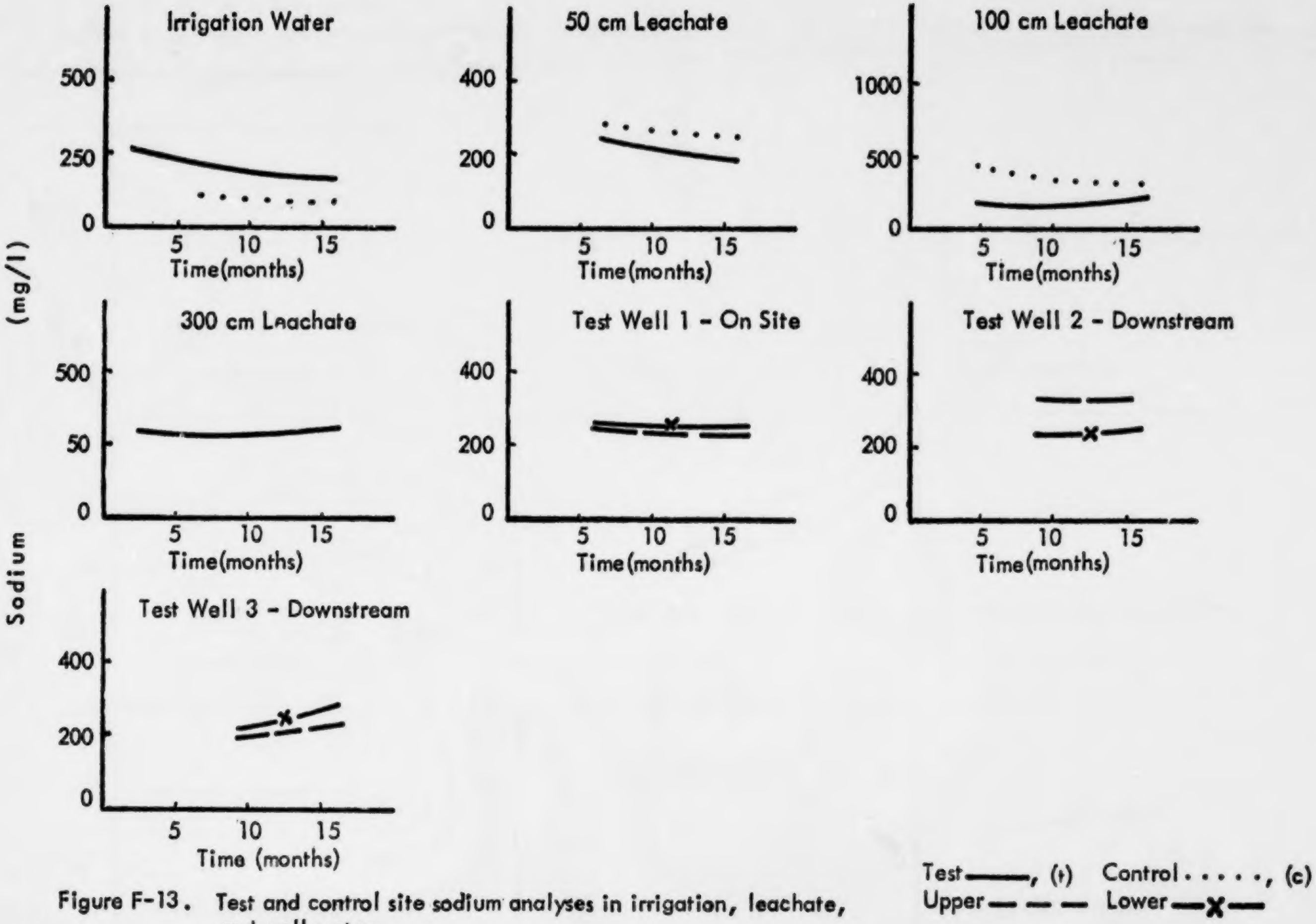


Figure F-13. Test and control site sodium analyses in irrigation, leachate, and well water.

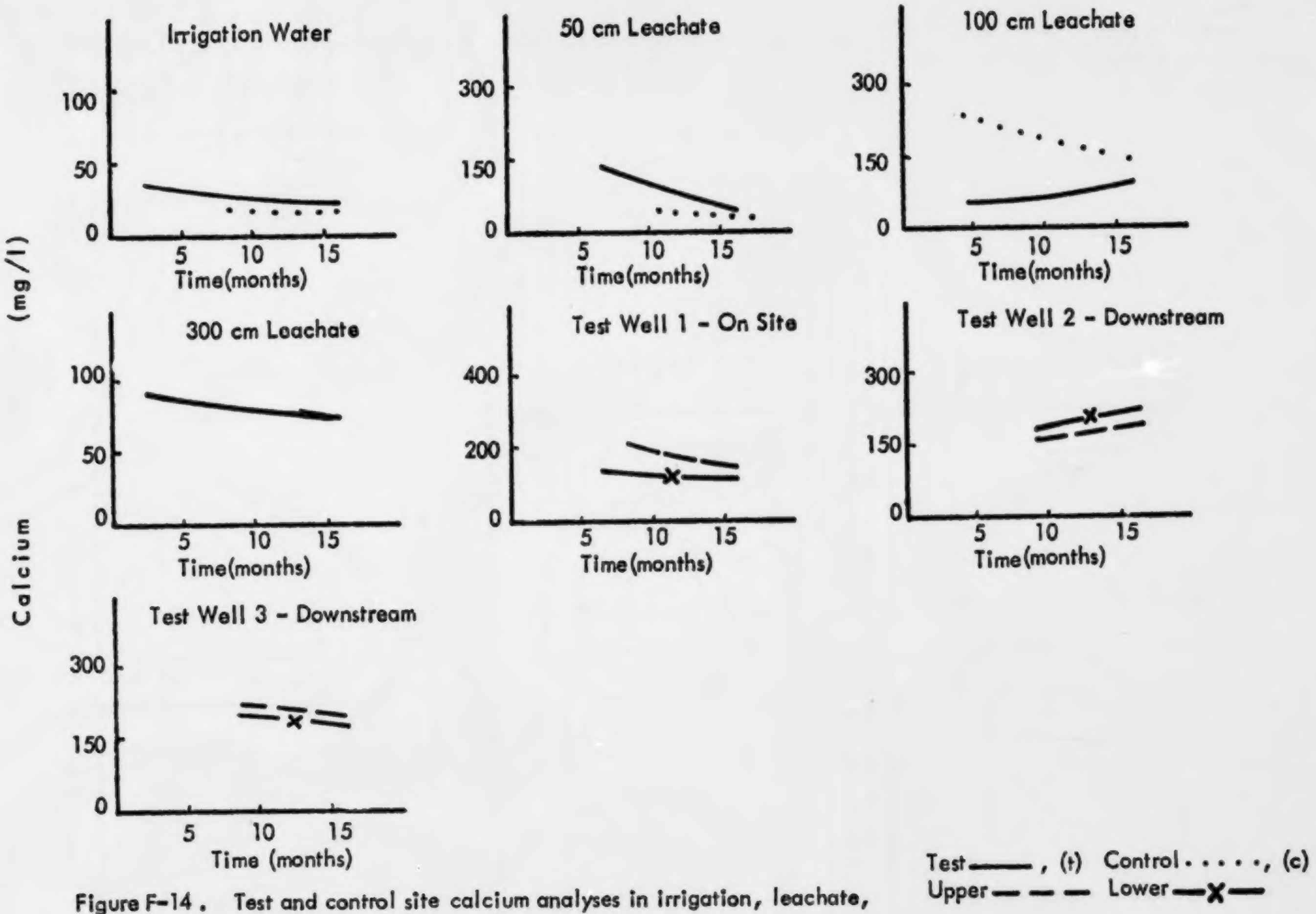


Figure F-14. Test and control site calcium analyses in irrigation, leachate, and well water.

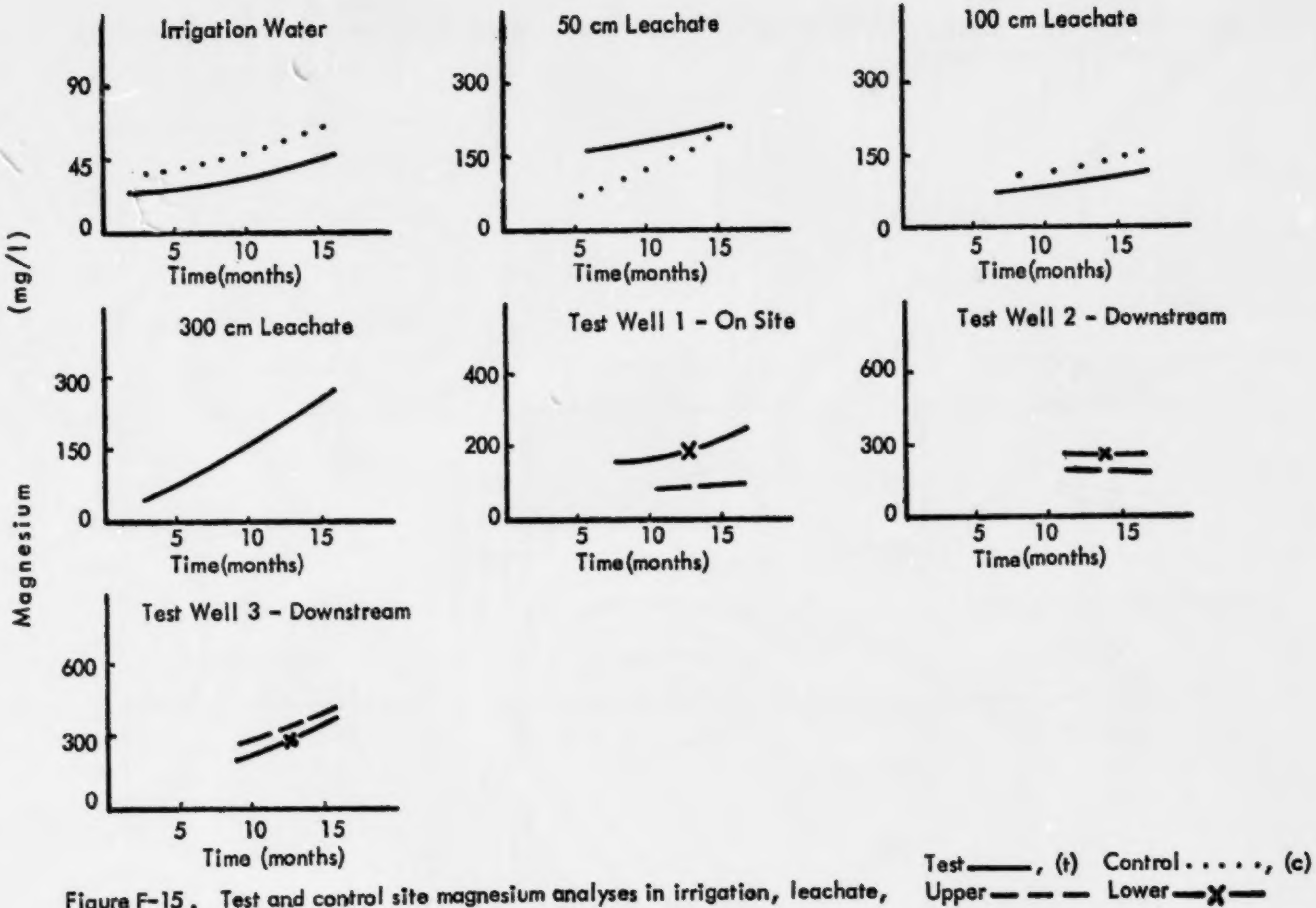


Figure F-15. Test and control site magnesium analyses in irrigation, leachate, and well water.

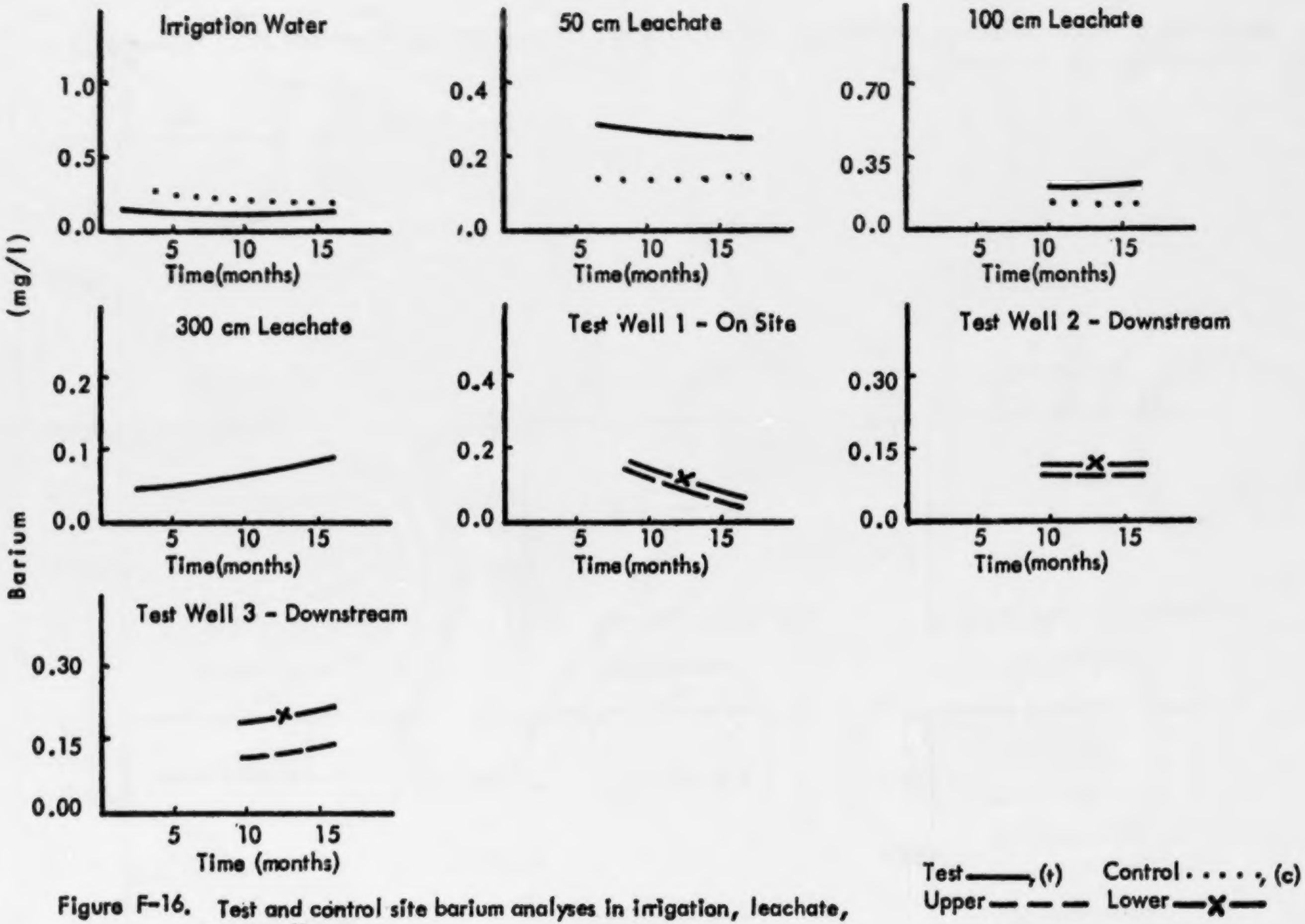


Figure F-16. Test and control site barium analyses in irrigation, leachate, and well water.

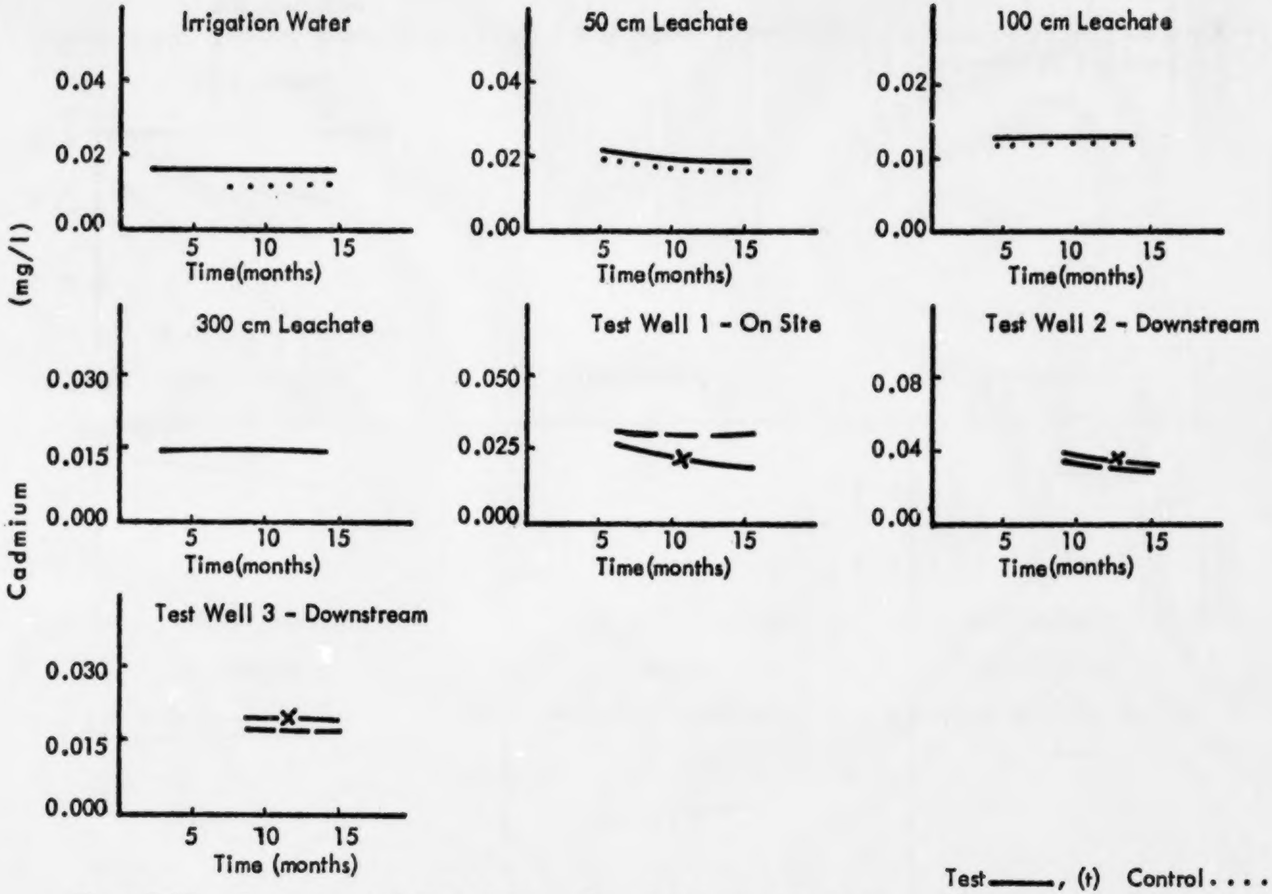


Figure F-17. Test and control site cadmium analyses in irrigation, leachate, and well water.

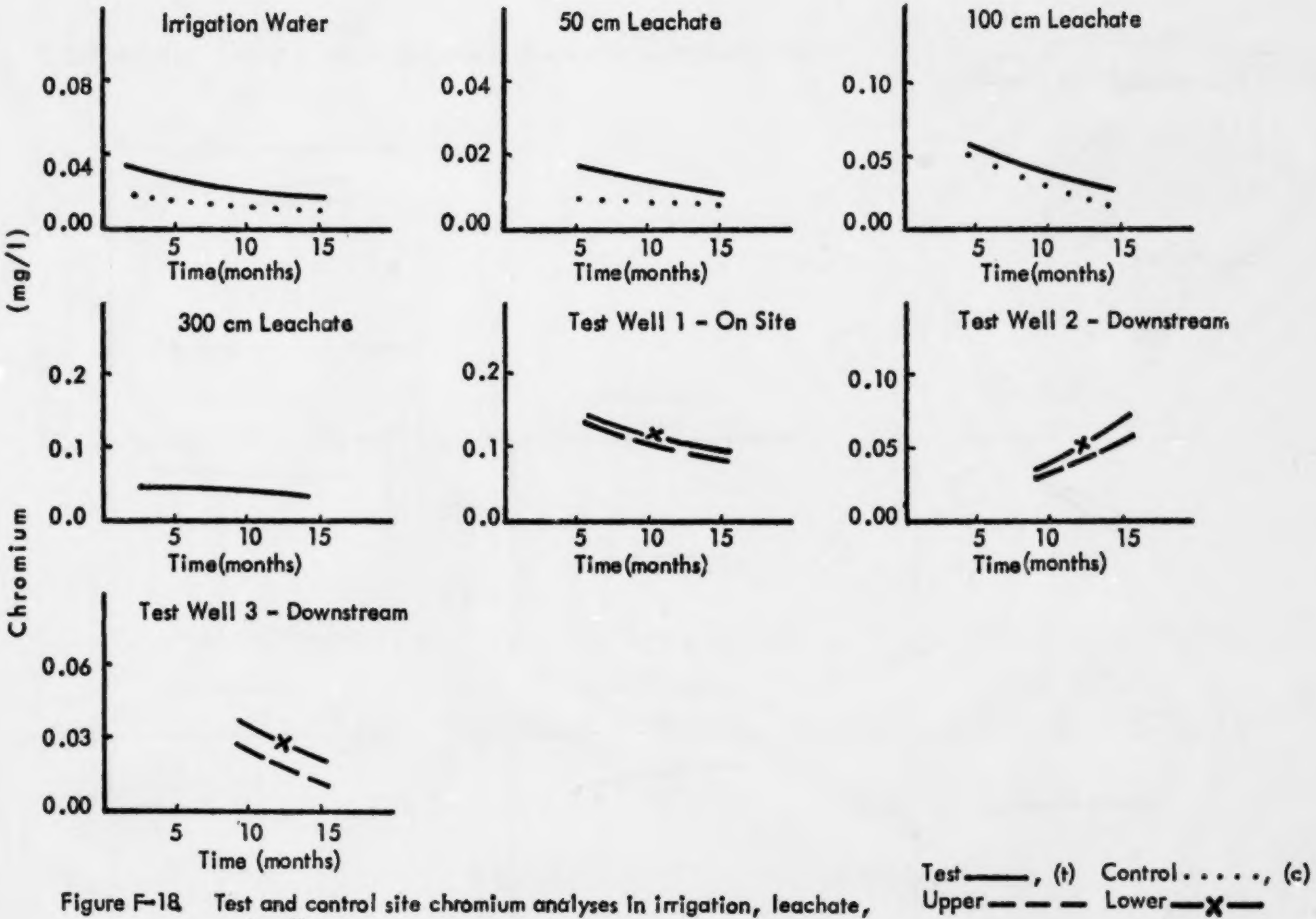


Figure F-18 Test and control site chromium analyses in irrigation, leachate, and well water.

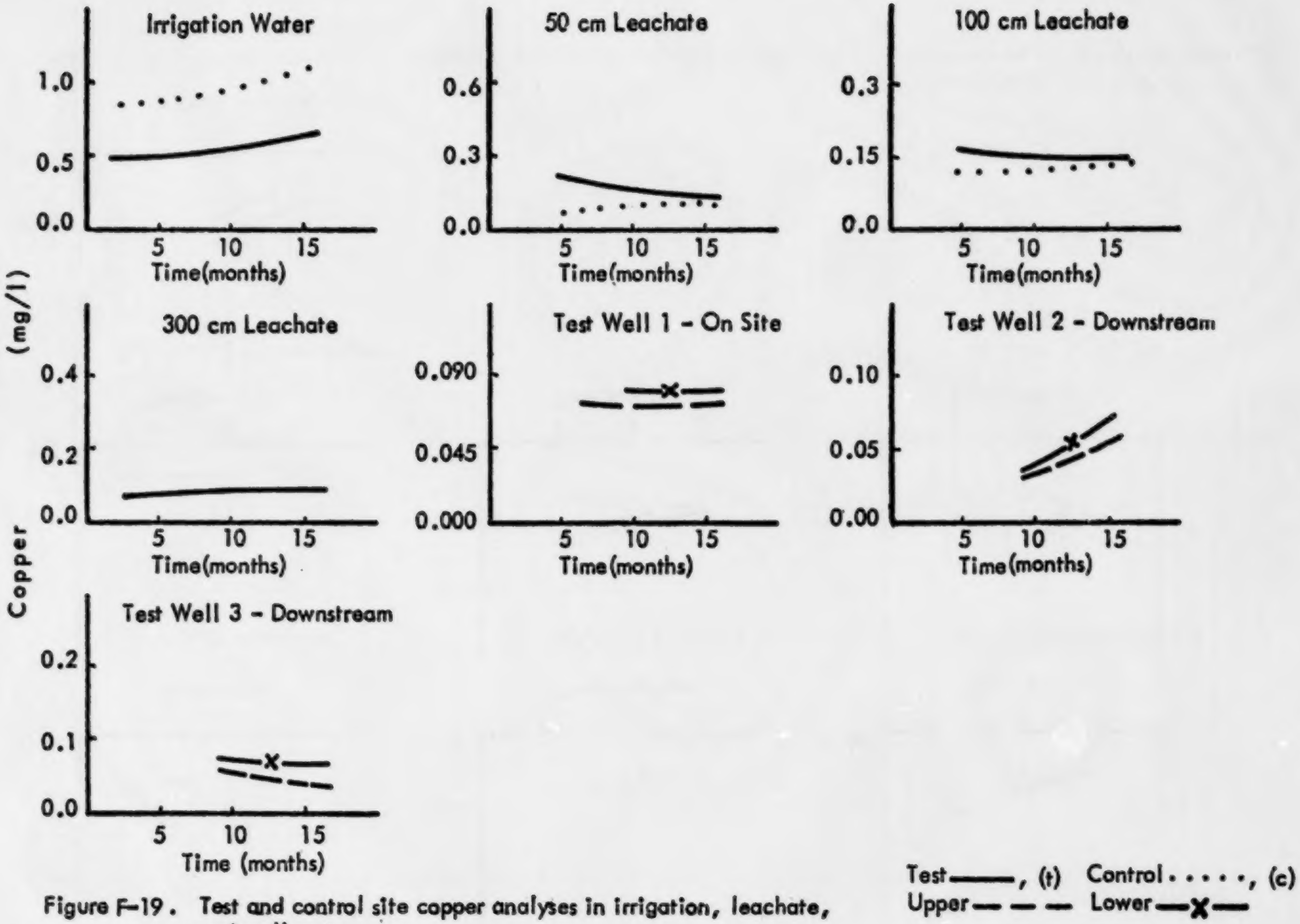


Figure F-19. Test and control site copper analyses in irrigation, leachate, and well water.

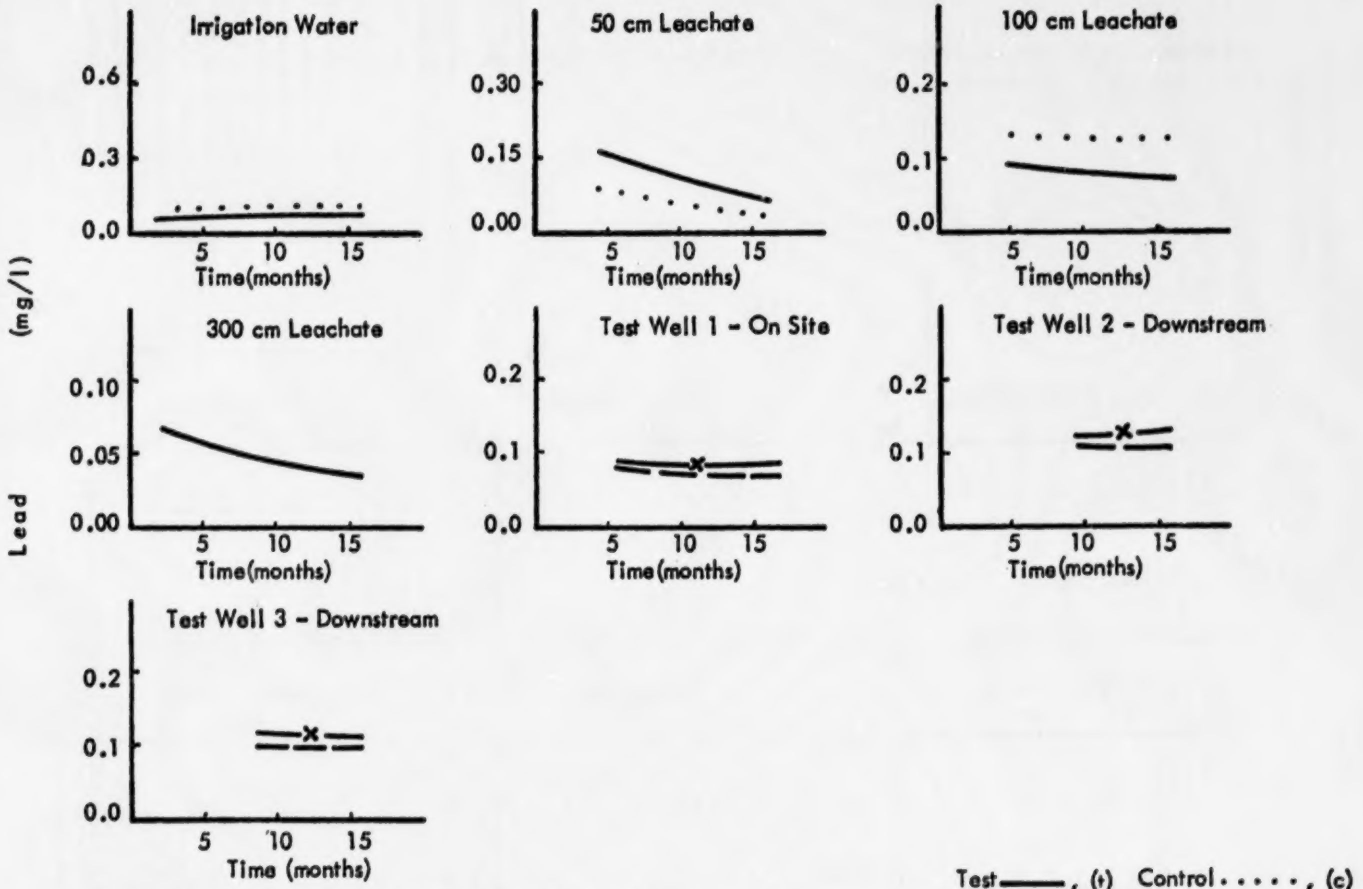


Figure F-20. Test and control site lead analyses in irrigation, leachate, and well water.

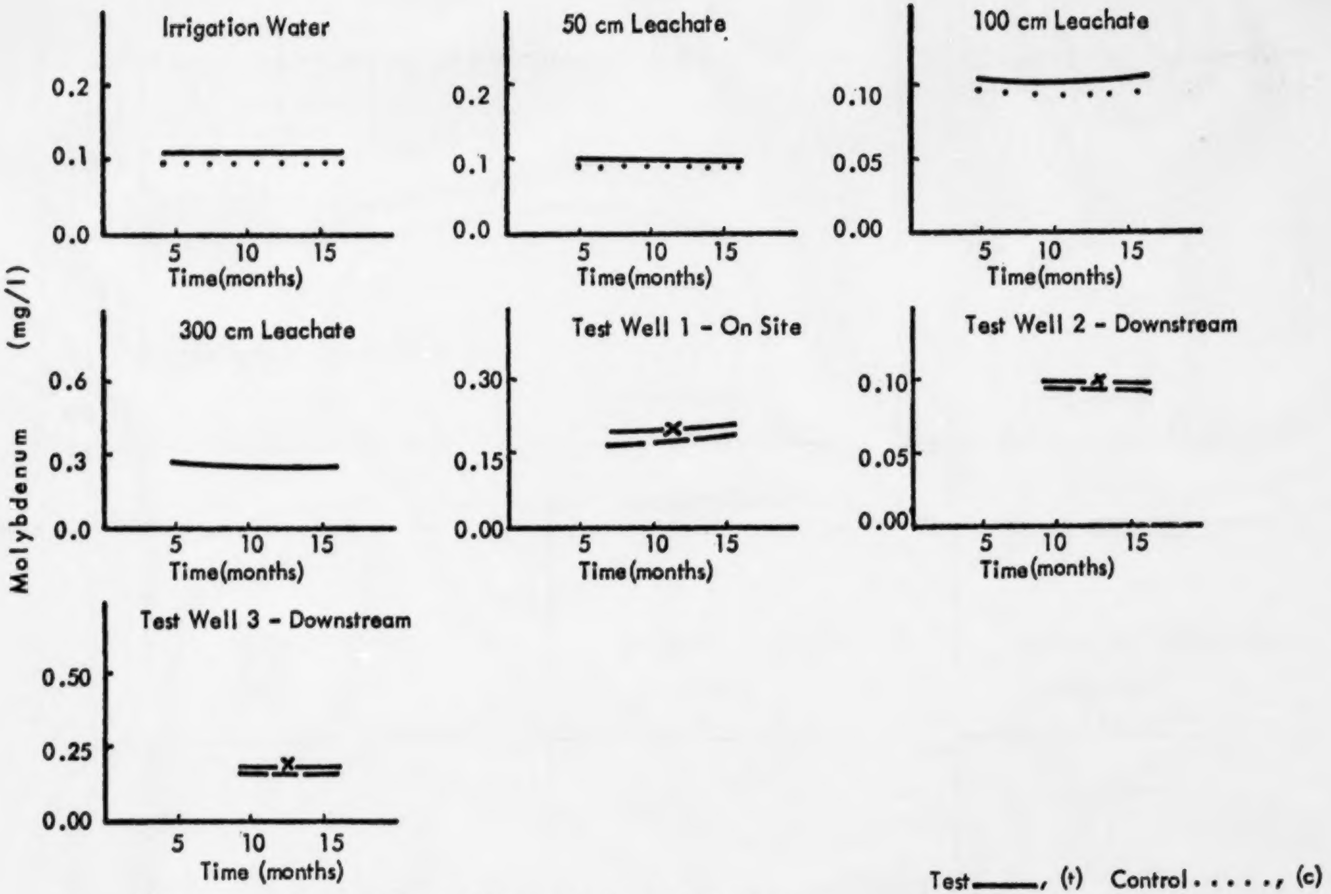


Figure F-21. Test and control site molybdenum analyses in irrigation, leachate, and well water.

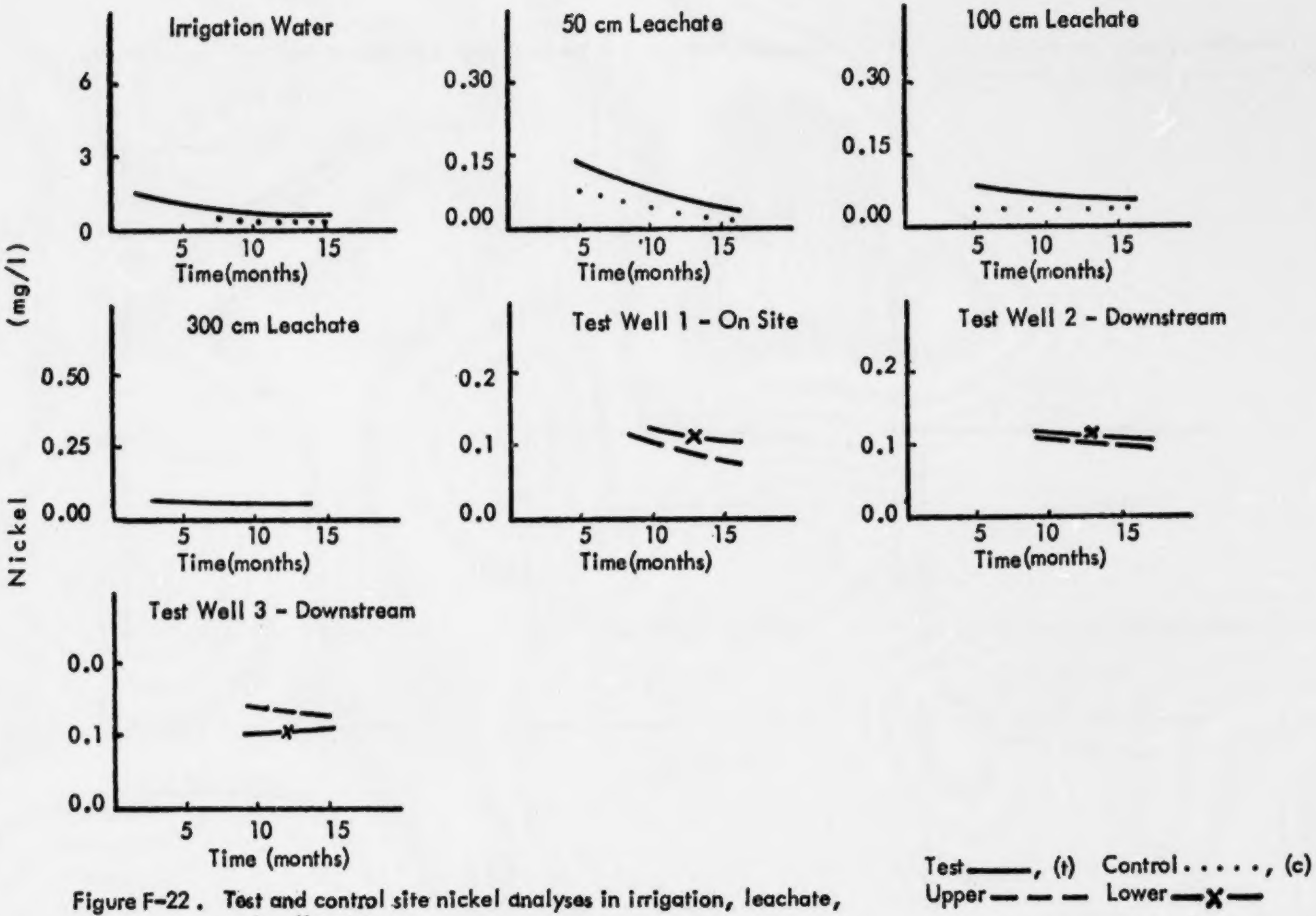
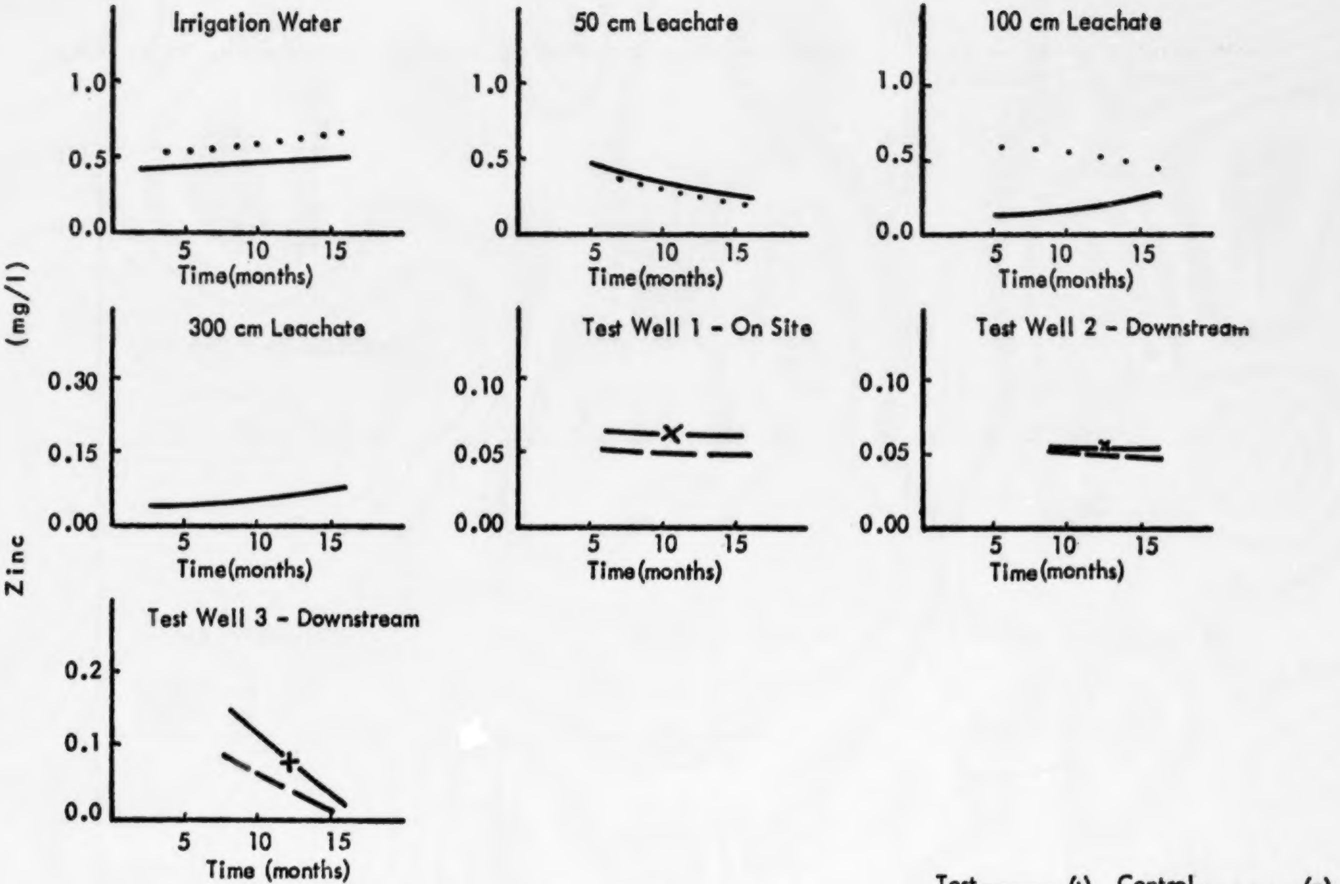


Figure F-22. Test and control site nickel analyses in irrigation, leachate, and well water.



Test———, (t) Control . . . . ., (c)
Upper — — — Lower —X—

Figure F-23. Test and control site zinc analyses in irrigation, leachate, and well water.

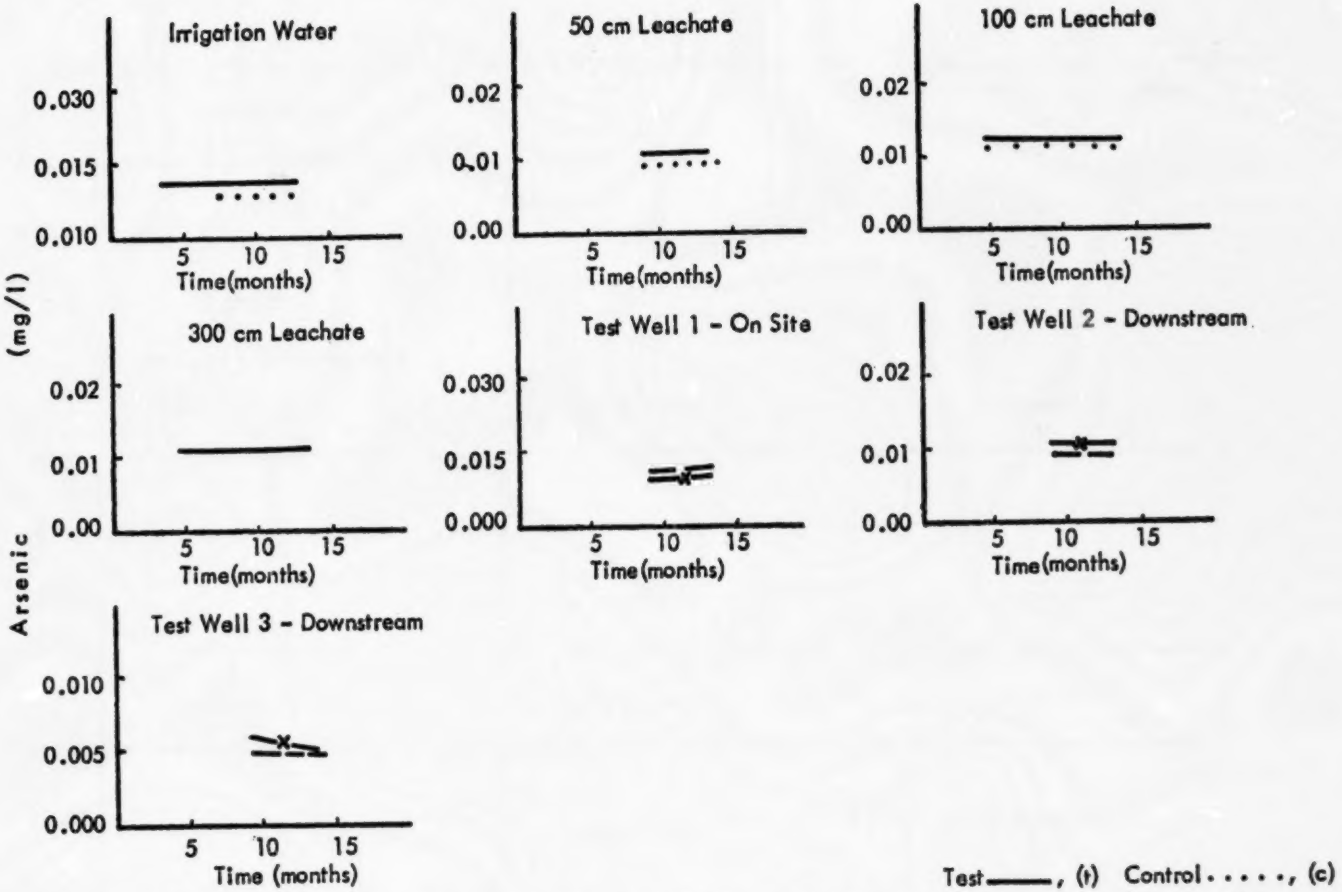


Figure F-24. Test and control site arsenic analyses in irrigation, leachate, and well water.

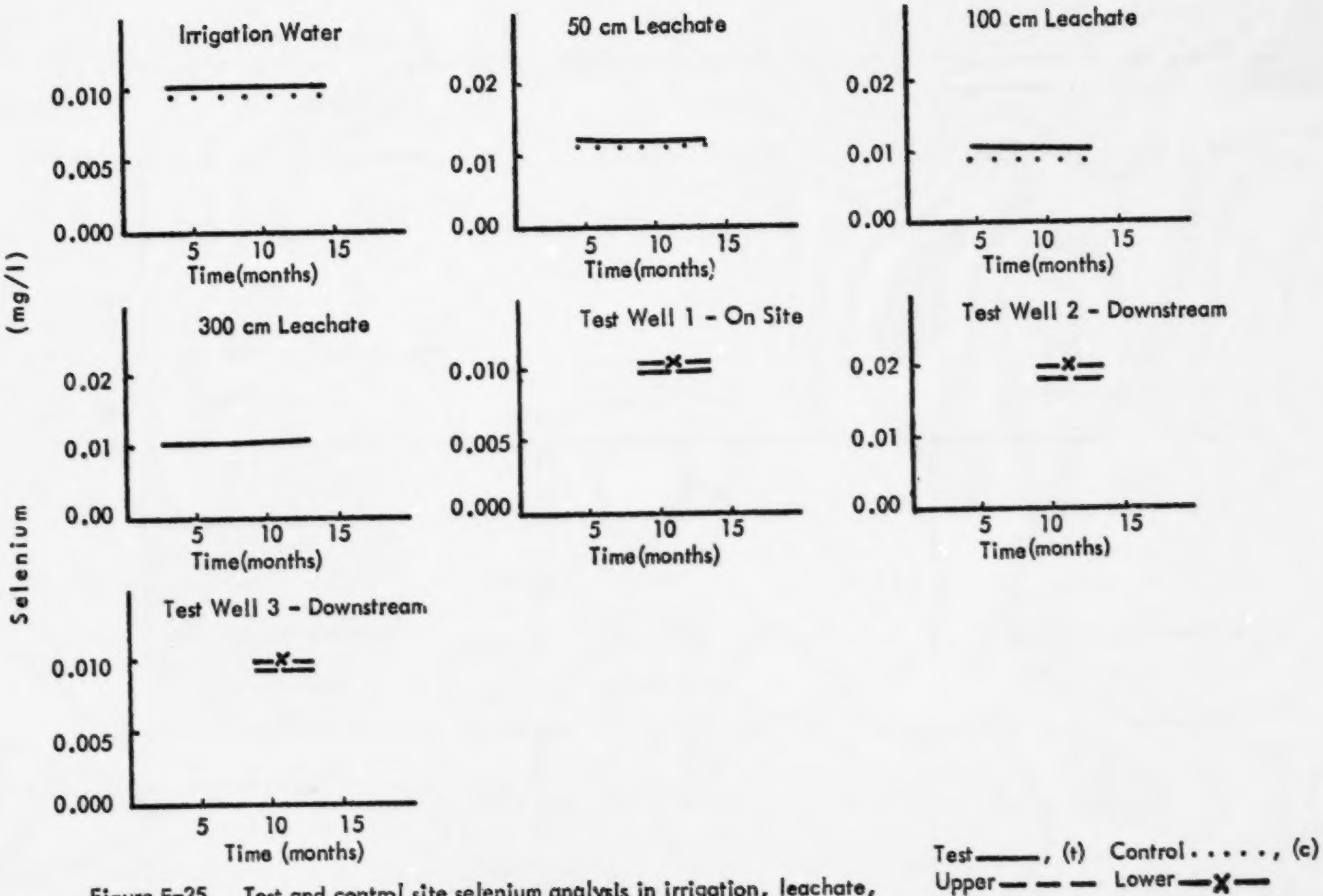


Figure F-25. Test and control site selenium analysis in irrigation, leachate, and well water.

APPENDIX G

AGRICULTURAL BALANCE TABLES

TABLE G-1. TEST SITE WATER BALANCE, 1971-1978

		Precipitation		Irrigation			Total Effective Water	Average Evapo-transpirations (cm)[d]	Average Leachate
Item	Year 19__ A	Total (cm) B	Effective[a] (cm) C	Total (1000 cu m) D	Total[b] (cm) E	Effective[c] (cm) F	(cm) G[e]	H	(cm) I[f]
	78[g]	16	12	NA	NA	NA	NA	NA	NA
	77	29	23	279	174	164	187	102	85
	76	28	22	281	176	165	187	102	85
	75	21	17	225	141	133	150	102	48
	74	36	29	242	152	143	172	102	70
	73	39	31	240	150	141	172	102	70
	72	28	22	273	171	161	183	102	91
	71	24	19	253	158	149	168	102	66
Total		205	163	1,793	1,122	1,056	1,219	714	505
Avg.		29	23	256	160	151	174	102	72

Test Area: 16 ha

Total effluent irrigated area: 182 ha

[a] Runoff coefficient is percent precipitation lost through surface runoff. Runoff coefficient = 0.2.

[b] Estimated values.

[c] Irrigation efficiency is the percent of the total applied which is not lost to runoff. Irrigation efficiency = 94%(estimated).

[d] Source: 7.

[e] G = C + F.

[f] I = G - H.

[g] January only (not included in averages).

TABLE G-2. CONTROL SITE WATER BALANCE, 1971-1978

		Precipitation		Irrigation					
Item	Year 19__ A	Total (cm) B	Effective[a] (cm) C	Total[b] (1000 cu m) D	Total[b] (cm) E	Effective[c] (cm) F	Total Effective Water (cm)[e] G	Average Evapo-transpira-tions (cm)[d] H	Average Leachate (cm)[f] I
	78[g]	16	12						
	77	29	23	303	151	150	173	102	71
	76	28	22	294	147	146	168	102	66
	75	21	17	278	139	138	155	102	53
	74	36	29	340	170	168	197	102	95
	73	39	31	335	167	165	196	102	94
	72	28	22	297	147	146	168	102	66
	71	24	19	306	153	151	170	102	68
Total		205	163	2,153	1,074	1,064	1,227	714	513
Avg.		29	23	308	153	152	175	102	73
Area: 20 ha									

[a] Runoff coefficient is percent of precipitation lost through surface runoff. Runoff coefficient: 0.2.

[b] Estimated value.

[c] Irrigation efficiency is the percent of the total applied which is not lost to runoff. Irrigation Efficiency =99%.

[d] Source: 7.

[e] G = C + F.

[f] I = G - H.

[g] January only (not included in averages).

Note: All numbers are rounded off to the nearest whole numbers.

TABLE G-3. TEST SITE ESTIMATED TOTAL WATER USED AND NUTRIENT SUPPLIED IN THE IRRIGATION WATER 1965-78

Item	Year 19__	Precipitation[a]		Irrigation[b]		Total Water		Fertilizer Value in Effluent Irrigation[c]								
		(cm/crop)[d]	(cm/yr)	(cm/crop)[d]	(cm/yr)	(cm/crop)[d]	(cm/yr)	(mg/l)			(kg/ha/crop)[d]			(kg/ha/yr)		
								N	P	K	N	P[h]	K	N	P[i]	K
	A	B	C	D	E	F[f]	G[g]		H			I			J	
	78[e]	8	16													
	77	15	29	87	174	102	204	25	10	20	217	87	174	435	174	348
	76	14	28	88	176	102	204	25	10	20	220	88	176	440	176	352
	75	10	21	70	141	80	162	25	10	20	175	70	140	350	140	280
	74	18	36	76	152	94	188	25	10	20	190	76	152	380	152	304
	73	19	39	75	150	94	189	25	10	20	188	75	150	375	150	300
	72	14	28	85	171	99	198	25	10	20	213	85	171	425	170	340
	71	12	24	79	158	91	182	25	10	20	197	79	158	395	158	316
	70	21	42	70	141	91	183	25	10	20	176	71	141	352	141	282
	69	27	54	76	151	103	206	25	10	20	190	76	152	380	152	304
	68	12	24	75	150	87	174	25	10	20	188	75	150	375	150	300
	67	23	46	85	170	108	216	25	10	20	213	85	170	425	170	340
	66	13	26	79	158	92	184	25	10	20	198	79	155	395	158	310
	65	23	47	70	141	93	188	25	10	20	176	71	141	352	141	282
	Total	229	460	1,015	2,033	1,236	2,478				2,541	1,017	2,029	5,079	2,033	4,058
	Avg.	18	35	78	156	95	191	25	10	20	195	78	156	391	156	312

[a] Camarillo Fire Station weather data.
[b] Site farmer.
[c] Estimated to be same as existing irrigation water.
[d] Based on two crops/year.
[e] January only.
[f] F = B + D
[g] G = C + E
[h] I = D × H
[i] J = E × H

Note: All numbers rounded off to nearest whole number.

TABLE G-4. CONTROL SITE ESTIMATED TOTAL WATER USED AND NUTRIENT SUPPLIED IN THE IRRIGATION WATER 1965-78

Item	Year 19__	Precipitation[a]		Irrigation[b]		Total Water		Fertilizer Value in Control Irrigation								
		(cm/crop)[d]	(cm/yr)	(cm/crop)[d]	(cm/yr)	(cm/crop)[d]	(cm/yr)	(mg/l)			(kg/ha/crop)[d]			(kg/ha/yr)		
	A	B	C	D	E	F	G[g]	N	P H	K	N	P I[h]	K	N	P J[i]	K
	78[e]	8	16													
	77	15	29	75	151	90	180	13	2	8	98	9	72	196	18	144
	76	14	28	73	147	87	175	13	2	8	95	9	70	191	17	140
	75	11	21	69	139	80	160	13	3	8	91	8	64	181	16	128
	74	18	36	85	170	103	206	13	2	8	111	10	83	221	20	165
	73	19	39	83	167	103	206	13	2	8	114	10	83	217	20	165
	72	14	28	73	147	87	175	13	2	8	95	9	70	191	17	140
	71	12	24	77	153	89	177	13	2	8	99	9	71	199	18	142
	70	21	42	73	145	93	187	13	2	8	95	9	75	189	19	150
	69	27	54	78	156	105	210	13	2	8	101	10	84	203	21	168
	68	12	24	85	169	97	193	13	2	8	110	9	77	220	19	154
	67	23	46	79	158	102	204	13	2	8	103	10	81	205	20	163
	66	13	26	81	162	94	188	13	2	8	105	9	75	211	19	150
	65	23	47	73	145	96	192	13	2	8	95	9	77	189	19	154
Total		230	460	1,004	2,009	1,226	2,453				1,312	120	982	2,613	243	1,963
Avg.		18	35	77	155	94	189	13	2	8	101	9	76	201	19	151

[a] Weather data: Camarillo Fire Station.

[b] Site farmer.

[c] Estimated to be same as existing irrigation water.

[d] Based on two crops/year.

[e] January only.

[f] F = B + D

[g] G = C + E

[h] I = D × H

[i] J = E × H

Note: All numbers rounded off to nearest whole number.

TABLE G-5. TEST SITE NUTRIENT BALANCE AND VALUE, 1965-77

Year 19___	Crop	Fertilizer Used[a] (%)			Fertilizer Applied[a] (kg/ha/crop)[c]	Fertilizer Applied[a] (kg/ha/yr)[d]	Recommended Fertilizer[b] (kg/ha/crop)[c]			Recommended Fertilizer[b] (kg/ha/yr)[d]			Fertilizer Cost[b] ($/ha/crop)[c]	Fertilizer Cost[b] ($/ha/yr)[d]
		N	P	K			N	P	K	N	P	K		
I	II		III		IV	V		VI			VII		VIII	IX
65	Tomato	17	27	0	560		90	30	60				108	
	Broccoli	11	48	0	392		150	250	0				108	
	"	26	14	0	449	1,401				240	280	60	76	292
66	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli		↓		↓	↓		↓			↓		↓	↓
	"		↓		↓	↓		↓			↓		↓	↓
67	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli		↓		↓	↓		↓			↓		↓	↓
	"		↓		↓	↓		↓			↓		↓	↓
68	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli		↓		↓	↓		↓			↓		↓	↓
	"		↓		↓	↓		↓			↓		↓	↓
69	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli		↓		↓	↓		↓			↓		↓	↓
	"		↓		↓	↓		↓			↓		↓	↓
70	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli		↓		↓	↓		↓			↓		↓	↓
	"		↓		↓	↓		↓			↓		↓	↓

(continued)

TABLE G-5 (continued)

Year 19___	Crop	Fertilizer Used[a] (%)			Fertilizer Applied		Recommended Fertilizer						Fertilizer Cost	
					(kg/ha/crop)[c]	(kg/ha/yr)[d]	(kg/ha/crop)[c]			(kg/ha/yr)[d]			($/ha/crop)[c]	($/ha/yr)[d]
		N	P	K			N	P	K	N	P	K		
I	II		III		IV	V		VI			VII		VIII	IX
71	Tomato	12	27	0	560		90	30	60				108	
	Broccoli	11	48	0	392		150	250	0				108	
	Broccoli	24	14	0	449	1,401				240	280	60.	76	292
72	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli													
	"													
73	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli													
	"													
74	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli													
	"													
75	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli													
	"													
76	Tomato	12	27	0	560	↓		↓			↓		↓	↓
	Broccoli	11	48	0	392									
	"	26	14	0	449									
77	Tomato	12	27	0	560									
	Broccoli	11	48	0	449									
	"	26	14	0	449	1,458								

(continued)

TABLE G-5(continued)

Year 19___	Crop	Fertilizer Used[a] (%)			Fertilizer Applied[a]		Recommended Fertilizer[b]						Fertilizer Cost[b]	
					(kg/ha/crop)[c]	(kg/ha/yr)[d]	(kg/ha/crop)[c]			(kg/ha/yr)[d]			($/ha/crop)[c]	($/ha/yr)[d]
		N	P	K			N	P	K	N	P	K		
I	II		III		IV	V		VI			VII		VIII	IX
Total						18,270				3,120	3,640	780		3,796
Avg.						1,405				240	280	60		292

(continued)

TABLE G-5 (continued)

Year	Fertilizer Nutrients[b]						Nutrients in Effective Irrigation Water[c]						Value of Nutrient in Irrigation[b]					
19__	(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/crop)[c]			(kg/ha/yr)[d]			($/ha/crop)[c]			($/ha/yr)[d]		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
		X			XI			XII			XIII			IV			XV	
65	67	151	0				156	63	125				103	42	82			
	43	188	0				155	62	124				102	41	82			
	108	63	0	218	402	0				311	125	249				205	83	164
66							186	75	146				123	49	96			
							186	74	145	372	149	291	123	49	96	246	98	192
67							200	80	160				132	53	105			
							199	80	160				131	53	106			
										399	160	320				263	106	211
68							177	71	141				117	46	93			
							176	70	141				116	47	93			
										353	141	282				233	93	186
69							179	72	143				118	47	95			
							178	71	143				118	47	94			
										357	143	286				236	94	189
70							166	66	133				109	44	88			
							165	67	132				109	44	87			
										331	133	265				218	88	175

(continued)

TABLE G-5(continued)

Year 19__	Fertilizer Nutrients[b]						Nutrients in Effective Irrigation Water[d]						Value of Nutrient in Irrigation[b]					
	(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/crop)[c]			(kg/ha/yr)[d]			($/ha/crop)[c]			($/ha/yr)[d]		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
		X			XI			XII			XIII			IV			XV	
71	67	151	0				186	75	149				123	48	98			
	43	188	0				187	74	149				123	48	97			
	108	63	0	218	402	0				373	149	298				246	98	197
72		↓			↓		202	81	161				133	53	107			
							201	80	161				133	53	106			
										403	161	322				266	106	213
73							177	71	141				117	47	93			
							176	70	141				116	46	93			
										353	141	282				233	93	186
74							179	72	143				118	47	95			
							178	71	143				118	47	94			
										357	143	286				236	94	189
75							167	67	133				110	44	88			
							166	66	133				110	44	88			
										333	133	266				220	88	176
76							207	83	165				137	55	109			
							206	82	165				136	54	109			
										413	165	330				273	109	218
77	67	151	0															
	49	216	0				205	82	164				136	54	108			
	108	63	0				205	82	163				135	54	108			
				224	430	0				410	164	328				271	108	216
Total				2,830	5,254	0				4,765	1,907	3,805				2,620	1,041	2,078
Avg.				218	402	0				367	147	293				200	80	160

(continued)

TABLE G-5 (continued)

Year	Total Nutrient Supplied						Nutrient Uptake by Crop						Nutrient Removal by Leachate		
	(kg/ha/crop)[c] XVI[g]			(kg/ha/yr)[d] XVII[h]			(kg/ha/crop)[c] XVIII[i]			(kg/ha/yr)[d] XIX			(kg/ha/yr)[d] XX		
19__	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
65	223	214	125				100	110	84						
	306	313	124				115	97	47						
				529	527	249				215	207	131	324	14	118
66	253	226	146				97	120	80						
	337	325	145				110	110	60						
				590	551	291				207	230	140	278	12	102
67	267	231	160				110	107	73						
	350	331	160				105	117	82						
				617	562	320				215	224	155	446	6	164
68	244	222	141				92	105	72						
	327	321	141				90	107	68						
				571	543	282				182	212	140	148	6	54
69	246	223	143				90	106	70						
	329	322	143				120	102	81						
				575	545	286				210	208	151	426	6	50
70	233	217	133				100	80	97						
	316	318	132				115	98	60						
				549	535	265				215	178	157	272	12	100
71	253	226	149				110	93	99						
	338	325	149				117	102	50						
				591	551	298				227	196	149	323	13	119

(continued)

TABLE G-5 (continued)

Year	Total Nutrient Supplied						Nutrient Uptake by Crop						Nutrient Removal by Leachate		
	(kg/ha/crop)[c] XVI[g]			(kg/ha/yr)[d] XVII[h]			(kg/ha/crop)[c] XVIII			(kg/ha/yr)[d] XIX			(kg/ha/yr)[d] XX		
19__	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
72	269	232	161				112	100	60						
	352	331	161	621	563	322	115	105	80	227	205	140	397	16	146
73	244	222	141				107	102	70						
	327	321	141	571	543	282	110	106	82	217	208	152	343	14	126
74	246	223	143				109	102	80						
	329	322	143	575	545	286	105	100	76	214	202	156	343	14	126
75	234	218	133				90	110	80						
	317	317	133	551	535	266	102	107	79	193	217	159	235	10	86
76	274	234	165				106	101	78						
	357	333	165	631	567	330	110	104	73	216	205	151	416	17	153
77	272	233	164				106	101	78						
	362	361	164	634	594	328	110	104	73	216	205	151	416	17	153
Total				7,605	7,161	3,805				2,754	2,697	1,932	4,367	157	1,497
Avg.				585	551	293				213	207	149	336	12	115

(continued)

TABLE G-5 (continued)

Year 19___	Nitrogen Losses to Atmosphere[f] (kg/ha/yr) XXI	Nutrient Residual in Topsoil (kg/ha/yr) N	P XXII[i]	K
65	10	-20	306	0
66	10	95	309	49
67	10	-54	332	1
68	10	231	325	88
69	10	-71	331	85
70	10	52	344	8
71	10	31	342	30
72	10	-13	343	36
73	10	1	321	4
74	10	8	329	4
75	10	113	308	21
76	10	-11	345	26
77	10	-8	372	24
Total	130	354	4,307	376
Avg.	10	27	331	29

(continued)

TABLE G-5 (continued)

[a] Site farmer.
[b] Ventura County Farm Advisor.
[c] Individual crop.
[d] Total crops.
[e] Estimated to be same as existing irrigation water.
[f] Estimated.
[g] XVI = X + XII (Columns).
[h] XVII = XI + XIII (Columns).
[i] XXII = XVII - (XIX + XX + XXI) (Columns).

TABLE G-6. CONTROL SITE NUTRIENT BALANCE AND VALUE, 1965-75

Year 19__	Crop	Fertilizer Used[a] (%)			Fertilizer Applied[a]		Recommended Fertilizer[b]						Fertilizer Cost[b]	
					[c] (kg/ha/crop)	[a] (kg/ha/yr)	[c] (kg/ha/crop)			[d] (kg/ha/yr)			[c] ($/ha/crop)	[d] ($/ha/yr)
		N	P	K			N	P	K	N	P	K		
I	II		III		IV	V		VI			VII		VIII	IX
65	Tomato	21	7	14	505		100	35	70				121	
	Broccoli	11	48	0	393		200	300	0				108	
	"	26	14	0	449	1,347				300	335	70	131	360
66	Tomato		↓		↓	↓		↓			↓		↓	
	Broccoli													
	"													
67	Tomato													
	Broccoli													
	"													
68	Tomato													
	Broccoli													
	"													
69	Tomato													
	Broccoli													
	"													
70	Tomato													
	Broccoli													
	"													

(continued)

TABLE G-6(continued)

Year 19___ I	Crop II	Fertilizer Used[a] (%) N	III P	K	Fertilizer Applied[a] (kg/ha/crop)[c] IV	(kg/ha/yr)[d] V	Recommended Fertilizer[b] (kg/ha/crop)[c] N	VI P	K	(kg/ha/yr)[d] N	VII P	K	Fertilizer Cost[b] ($/ha/crop)[c] VIII	($/ha/yr)[d] IX
71	Tomato	21	7	14	505		100	35	70				121	
	Broccoli	11	48	0	393		200	300	0				108	
		26	14	0	449	1,347				300	335	70	131	360
72	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli													
	"													
73	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli													
	"													
74	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli													
	"													
75	Tomato		↓		↓	↓		↓			↓		↓	↓
	Broccoli													
	"													
76	Tomato	21	7	14	505		100	35	70				121	
	Spinach	11	48	0	449		387	79	79				123	
	"	26	14	0	449	1,403				487	114	149	131	375
77	Tomato	21	7	14	505		100	35	70				121	
	Broccoli	11	48	0	449		200	300	0				108	

(continued)

TABLE G-6 (continued)

Year 19___	Crop	Fertilizer Used[a] (%)			Fertilizer Applied[a] c (kg/ha/crop)	Fertilizer Applied[a] d (kg/ha/yr)	Recommended Fertilizer[b] c (kg/ha/crop)			Recommended Fertilizer[b] d (kg/ha/yr)			Fertilizer Cost[b] c ($/ha/crop)	Fertilizer Cost[b] d ($/ha/yr)
		N	P	K			N	P	K	N	P	K		
I	II		III		IV	V		VI			VII		VIII	IX
77 (cont.)	Broccoli	26	14	0	449	1,403					335	70	131	360
Total						17,758				4,087	4,134	489		4,695
Avg.						1,366				314	318	76		361

(continued)

TABLE G-6 (continued)

Year	Fertilizer Nutrients[b]						Nutrients in Effective Irrigation Water[e]						Value of Nutrient In Irrigation[b]					
	(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/crop)[c]			(kg/ha/yr)[d]			($/ha/crop)[c]			($/ha/yr)[d]		
19__	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
		X			XI			XII			XIII			XIV			XV	
65	106	35	71				91	10	76				62	7	50			
	43	189	0				93	9	76	187	19	152	60	6	50			
	117	63	0	266	287	71										123	13	100
66		↓			↓		105	10	75				69	7	49			
							104	9	74				69	6	49			
										209	19	149				138	13	98
67		↓			↓		102	10	81				67	7	53			
							101	10	80				67	6	53			
										203	20	161				134	13	106
68		↓			↓		109	10	77				72	7	51			
							109	9	77				72	6	51			
										218	19	154				144	13	102
69		↓			↓		101	11	83				67	7	55			
							100	10	83				66	7	55			
										201	21	166				133	14	110
70		↓			↓		94	10	75				62	7	49			
							93	9	74				61	6	49			
										187	19	149				123	13	98

(continued)

TABLE G-6 (continued)

Year	Fertilizer Nutrients[b]						Nutrients in Effective Irrigation Water[e]						Value of Nutrient in Irrigation[b]					
	(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/crop)[c]			(kg/ha/yr)[d]			($/ha/crop)[c]			($/ha/yr)[d]		
19__	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
	X			XI			XII			XIII			XIV			XV		
71	106	35	71				99	9	71				65	6	47			
	43	189	0				98	9	70				65	6	46			
	117	63	0	266	287	71	--	--		197	18	141				130	12	93
72		↓			↓		95	9	70				63	6	46			
		↓			↓		94	8	69				62	5	46			
										189	17	139				125	11	92
73		↓			↓		108	10	82				71	7	54			
		↓			↓		107	10	81				71	6	54			
										215	20	163				142	13	108
74		↓			↓		110	10	82				73	7	54			
		↓			↓		109	10	81				72	6	54			
										219	20	163				145	13	108
75		↓			↓		90	8	64				59	6	42			
		↓			↓		89	8	63				59	5	42			
										179	16	127				118	11	84
76	106	35	71				95	9	70				63	6	46			
	49	215	0				94	8	69				62	5	46			
	117	63	0	272	313	71				189	17	139				125	11	92
77	106	35	71				97	9	72				64	6	47			
	49	215	0				97	9	71				64	6	47			

(continued)

TABLE G-6 (continued)

Year 19__	Fertilizer Nutrients[b]						Nutrients in Effective Irrigation Water[c]						Value of Nutrient in Irrigation[b]					
	(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/crop)[c]			(kg/ha/yr)[d]			($/ha/crop)[c]			($/ha/yr)[d]		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
		X			XI			XII			XIII			IV			XV	
77 (cont.)	117	63	0	272	313	71				194	18	143				128	12	94
Total				3,470	3,783	923				2,587	243	1,946				1,708	162	1,285
Avg.				267	291	71				199	19	150				131	12	99

(continued)

TABLE G-6 (continued)

Year 19	Total Nutrient Supplied						Nutrient Uptake by Crop[f]						Nutrient Removal by Leachate		
	(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/yr)[d]		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
	XVI[g]			XVII[h]			XVIII			XIX			XX		
65	200	45	147				80	120	80						
	253	261	76				100	90	40						
				453	306	223				180	210	120	367	30	116
66	211	45	146				88	152	83						
	264	261	74				120	92	53						
				475	306	220				208	244	236	268	22	84
67	208	45	152				74	140	80						
	261	262	80				100	84	45						
				469	307	232				74	224	125	390	31	123
68	215	45	148				80	110	84						
	269	261	77				130	93	52						
				484	306	225				210	203	136	357	29	113
69	207	46	154				100	107	81						
	260	262	83				138	95	82						
				467	308	237				238	202	163	403	32	127
70	200	45	146				80	120	80						
	253	261	74				130	92	53						
				453	306	220				210	212	133	273	22	86

(continued)

TABLE G-6(continued)

Year 19___	Total Nutrient Supplied						Nutrient Uptake by Crop[f]						Nutrient Removal by Leachate		
	(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/yr)[d]		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
	XVI[g]			XVII[h]			XVIII			XIX			XX		
71	205	44	142				102	120	82						
	258	261	70				140	100	63						
				463	305	212				242	220	145	258	20	82
72	201	44	141				95	110	85						
	254	260	69				135	102	107						
				455	304	210				230	212	192	251	20	79
73	214	45	153				92	115	103						
	267	262	81				102	107	100						
				481	307	234				194	222	203	357	28	113
74	216	45	153				90	107	80						
	269	262	81				100	118	60						
				485	307	234				190	225	140	361	29	114
75	196	43	135				80	100	120						
	249	260	63				100	110	130						
				445	302	198				180	210	250	201	16	64
76	201	44	141				92	110	94						
	254	260	69				103	64	80						
				461	330	210				195	174	174	251	20	79
77	203	44	143				84	125	81						
	257	287	71				120	91	54						

(continued)

TABLE G-6. (continued)

Year	Total Nutrient Supplied						Nutrient Uptake by Crop[f]						Nutrient Removal by Leachate		
	(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/crop)[c]			(kg/ha/yr)[d]			(kg/ha/yr)[d]		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
19	XVI-			XVII[h]			XVIII			XIX			XX		
77 (cont.)				466	331	214				204	216	135	270	21	85
Total				6,057	4,026	2,869				2,655	2,774	2,152	4,007	320	1,265
Avg.				466	310	221				204	213	166	308	25	95

(continued)

TABLE G-6 (continued)

Year 19___	Nitrogen Losses to Atmosphere[f] (kg/ha/yr) XXI	Nutrient Residual in Topsoil (kg/ha/yr) N	P XXII[i]	K
65	10	-104	66	-13
66	10	-11	40	-100
67	10	-105	52	-16
68	10	-93	74	-24
69	10	-184	74	-53
70	10	-40	72	1
71	10	-47	65	-15
72	10	-36	72	-61
73	10	-80	57	-82
74	10	-76	53	-20
75	10	54	77	-116
76	10	5	136	-43
77	10	-18	94	-6
Total	130	-735	932	-548
Avg.	10	-57	72	-42

(continued)

TABLE G-6 (continued)

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[a] Site farmer.

[b] Ventura County Farm Advisor.

[c] Individual crop.

[d] Total crops.

[e] Estimated to be same as existing irrigation water.

[f] Estimated.

[g] XVI = X + XII (columns).

[h] XVII = XI + XIII (columns)

[i] XXII = XVII - (XIX + XX + XXI) (columns).

TABLE G-7. TEST SITE CROP YIELD AND NUTRIENT UPTAKE, 1965-77

Year[c] 19__	Crop[c]	Yield Green Weight (tons/ ha/yr)	Yield Dry Weight[e] (tons/ha/yr)	Nutrient Supplied[f] (kg/ha/yr)			Nutrient Uptake[f] (kg/ha/yr)			Uptake Efficiency (%)			Combined Nutrient Uptake Efficiency (%)
				N	P	K	N	P	K	N	P	K	
65	[a]Tomato	100	8.3				100	110	84				
	[b]Broccoli	38	2.8	529	527	249	115	97	47	41	79	53	58
66	1	97	8.1				97	120	80				
	2	37	2.7	590	551	291	110	110	60	35	42	48	42
67	1	107	8.9				110	107	73				
	2	37	2.7	617	562	320	105	117	82	35	40	48	41
68	1	92	7.6				92	105	72				
	2	30	2.2	571	543	282	90	107	68	32	39	50	40
69	1	90	7.5				90	160	70				
	2	40	3.0	575	545	286	120	102	81	37	48	53	46
70	1	100	8.3				100	80	97				
	2	38	2.8	549	525	265	115	98	60	39	34	59	44
71	1	110	9.1				110	93	99				
	2	38	2.8	591	551	298	117	103	50	38	36	50	41
72	1	112	9.3				112	100	60				
	2	38	2.8	621	563	322	115	105	80	37	36	43	39

(Continued)

TABLE G-7 (continued)

Year 19___	Crop[a]	Yield Green Weight[d] (1000 kg/ha/yr)	Yield Dry Weight[c] (1000 kg/ha/yr)	Nutrient Supplied[f] (kg/ha/yr)			Nutrient Uptake[f] (kg/ha/yr)			Uptake Efficiency (%)			Combined Nutrient Uptake Efficiency (%)
				N	P	K	N	P	K	N	P	K	
73	1	107	8.9				107	102	70				
	2	38	2.8	571	543	282	110	106	82	38	41	54	44
74	1	109	9.0				109	102	80				
	2	37	2.7	575	545	286	105	100	76	37	38	59	45
75	1	90	7.5				90	110	80				
	2	37	2.7	541	535	266	103	107	79	36	41	60	46
76	1	102	8.5				106	101	78				
	2	37	2.7	631	567	330	110	104	73	34	36	46	49
77	1	99	8.2				103	105	77				
	2	37	2.7	634	594	328	107	104	77	33	35	50	39
Total				7,595	7,151	3,805	2,758	2,701	1,935				
Avg.				584	547	291	212	208	149	36	42	52	43

[a] Tomato = 1.
[b] Broccoli = 2.
[c] Site farmer.
[d] Source 26

[e] Estimate: Tomato dry weight = 8.3% of green wt.
Broccoli dry weight = 7.4% of green wt.
[f] Estimated.

TABLE G-8. CONTROL SITE CROP YIELD AND NUTRIENT UPTAKE, 1965-77

Year 19__	Crop	Yield Green Weight[d] (1000 kg/ha/yr)	Yield Dry Weight[e] (1000 kg/ha/yr)	Nutrient Supplied[f] (kg/ha/yr)			Nutrient Uptake[f] (kg/ha/yr)			Uptake Efficiency (%)			Combined Nutrient Uptake Efficiency (%)
				N	P	K	N	P	K	N	P	K	
65	[a]Tomato	80	6.6				80	120	80				
	[b]Broccoli	32	2.4	453	306	223	100	90	40	40	69	54	54
66	1	88	7.4				88	152	83				
	2	38	2.8	475	306	220	120	92	53	44	80	52	62
67	1	74	6.2				74	140	80				
	2	32	2.4	469	307	232	100	84	45	37	73	54	55
68	1	80	6.6				80	110	84				
	2	42	3.1	484	306	225	130	93	52	43	66	60	56
69	1	100	8.4				100	107	81				
	2	44	3.3	467	308	237	138	95	82	51	66	69	62
70	1	80	6.1				80	120	80				
	2	42	3.1	453	306	220	130	92	53	46	69	60	58
71	1	102	8.6				102	120	82				
	2	102	8.6	463	305	212	140	100	63	52	72	68	64
72	1	95	8.0				95	110	85				
	2	43	3.2	455	304	210	135	102	107	51	70	91	71

(continued)

TABLE G-8 (continued)

Year 19___	Crop[c]	Yield Green Weight[d] (1000 kg/ha/yr)	Yield Dry Weight[e] (1000 kg/ha/yr)	Nutrient Supplied (kg/ha/yr)[f] N	P	K	Nutrient Uptake[f] (kg/ha/yr) N	P	K	Uptake Efficiency (%) N	P	K	Combined Nutrient Uptake Efficiency (%)
73	1	92	7.7				92	115	103				
	2	33	2.4	481	307	234	102	107	100	40	72	87	66
74	1	90	7.6				90	107	80				
	2	32	2.4	485	307	234	100	118	60	39	73	60	57
75	1	80	6.7				80	100	120				
	2	32	2.4	445	303	198	100	110	130	40	69	100	70
76	1	100	8.4				92	110	94				
	Spinach	11	0.8	445	304	210	103	64	80	44	57	83	61
77	1	105	9.2				84	125	81				
	2	31	2.3	460	331	214	120	91	54	44	65	63	57
Total				6,045	4,000	2,869	2,835	2,774	2,152				
Avg.				465	308	221	218	213	166	44	69	70	61

[a] Tomato = 1.

[b] Broccoli= 2.

[c] Site farmer.

[d] Estimate based on Cost and Practices for Row Crops in Ventura County, Pub. by Co-operative Extension, Univ. of Calif. Ventura, Calif. Dec. 1975.

[e] Estimate: Tomato dry weight = 8.3 of green wt.
Broccoli dry weight = 7.4% of green wt.

[f] Estimated.

TABLE G-9 . TEST AND CONTROL SITES CROP COSTS AND SALES COMPARISON ($/ha)[a,b]

Year 19___	Site & Crop	Cultivation	Irrigation Water	Fertilizing[c]	Harvesting, Packaging, & Selling	Land[d]	Total Costs	Crop Sales Price	Estimated Profit
77	Test Site								
	Tomato	775	103[e]	92	1,306	432	2,708	1,089	- 1,619
	Broccoli	944	68[e]	184	495	309	2,000	2,174	174
	Control Site								
	Tomato	775	445	92	1,306	432	3,050	1,089	- 1,961
	Broccoli	944	272[f]	184	495	309	2,138	1,976	- 162
76	Test Site								
	Tomato	720	87[e]	83	1,221	432	2,543	3,503	960
	Broccoli	883	61[e]	172	430	309	1,855	2,179	324
	Control Site								
	Tomato	720	361	83	1,221	432	2,817	3,503	686
	Spinach	457	296	166	0	309	1,228	1,482	254
75	Test Site								
	Tomato	674	80[e]	79	1,136	432	2,401	4,095	1,694
	Broccoli	821	53[e]	184	430	309	1,797	2,870	1,073
	Control Site								
	Tomato	674	361	79	1,136	432	2,682	4,095	1,413
	Broccoli	821	241	184	430	309	1,985	2,870	885

(continued)

TABLE G-9. (continued)

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[a] This table is based on 1975-1978 costs. Costs for the years 1965-1974 would be relatively similar, but vary with the economic factors for those years.

[b] From Cost and Practices for Row Crops in Ventura County. Cooperative Extension, University of California.

[c] From Table 33 on Nutrient Balances for Camarillo, California sites.

[d] Based on $61.75/hectare-month for appropriate growing period, from Source 1.

[e] Farmer uses fresh water for sprinkler irrigation at planting time, and for final irrigation before harvest.

[f] The final irrigation and fertilizer application were omitted due to rain.

APPENDIX H

CONTRACTS WITH FARMERS

CAMARILLO TEST SITE LEASE

AGRICULTURAL LEASE

This Lease is executed at Camarillo, California, on the _____ day of by and between MARY H. SMITH, TRUSTEE OF THE MARY H. SMITH TRUST, JOSEPH R. HOWARD and PATRICIA C. HOWARD, husband and wife, and CONEJO MOUNTAIN MEMORIAL PARK, a California corporation, hereinafter collectively called "Landlord" and RIP BRUCKER RANCH CO., a California corporation, hereinafter called "Tenant."

Recitals:

Landlord severally but collectively owns certain parcels of real property described in Exhibit "A" attached hereto and Tenant desires to lease said property for purposes of farming. Therefore, it is agreed between the parties hereto as follows:

1. Property Leased: Landlord hereby leases to Tenant the following real property situated in the County of Ventura, State of California:

a. The premises with the appurtenances consisting of a total of three hundred sixty and nine-tenths (360.9) acres usable for farming row crops; said acreage and area and the allocation of rent among the area is more particularly described in Exhibit "A" attached hereto and made a part hereof. The property owned by Ben Zolin is not included or a part of this Lease.

2. Term: The term of this Lease shall begin on the first day of and end on the thirty-first day of unless sooner terminated as hereinafter provided.

3. Rental: Tenant agrees to pay to Landlord an annual rental for the use and occupancy of the premises described in Exhibit "A" in the amount of Dollars ( ), payable in quarterly installments of DOLLARS ( ) in advance commencing and thereafter on the first day of April and July and October during the term hereof. Tenant's obligation, if any, pursuant to paragraph 10b of the Lease shall be payable together with the January installment of rent.

Except as hereinafter provided in paragraph 11d, no deductions or offsets shall be made against the rentals accruing and becoming due in any year during the Lease term.

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7. Water - Water Supply: The parties hereto acknowledge that an agreement between MARY H. SMITH and the Camarillo Sanitary District gives to MARY H. SMITH the right to the use of water from the Camarillo Sanitary District facilities located on Exhibit "A" at no charge to MARY H. SMITH. Therefore, as long as MARY H. SMITH has the right to use said water from the Camarillo Sanitary District, without charge, Landlord will use its best efforts to supply or cause to be supplied to Tenant from the Camarillo Sanitary District facilities the water necessary for proper irrigation during the term of this Lease, without charge; provided that Tenant agrees to pay all cost connected with transporting the water to the reservoir. Tenant shall use all water supplied from the Camarillo Sanitary District exclusively upon the leased premises and said water shall not be suffered by Tenant to go to waste. Landlord does not and shall not warrant the sufficiency or suitability of water supplied to the leased premises, and shall not at any time during the lease term be liable in damages or otherwise for the failure to supply water hereunder for any cause beyond the reasonable control of Landlord. In the event that the water supply should become insufficient for agricultural purposes or should become contaminated so that farming cannot be continued on the leased premises, Tenant shall have the right, upon sixty (60) days written notice to terminate all or a portion of this Lease. In the event that the Camarillo Sanitary District levies a charge for the water now being supplied to MARY H. SMITH and the leased premises, Tenant shall promptly reimburse for Tenant's use of the water in proportion to the total use of the water supplied by Camarillo Sanitary District, or in the alternative, Landlord shall have the right, upon ninety (90) days written notice to Tenant to terminate this Lease.

The use of the water well depicted in Exhibit "A" is for domestic purposes only and is not to be used for agricultural purposes as herein described.

8. Disclaimer of Warranty - Soil Suitability: Landlord makes no warranty of the soil suitability for growing the crops that Tenant may grow under the terms of this Lease.

9. Utilities: Tenant shall pay for all electric power and other services supplied to the leased premises.

10. Taxes:

a. All state, county and local taxes which, during the term of this Lease, may be levied on or become due against all buildings constructed by Tenant, equipment, crops and/or personal property owned by Tenant shall be paid by Tenant.

4. Payment of Rent: Installment rent payments shall be made payable to MARY H. SMITH or NOMINEE as agent for the various Landlords of said premises.

5. Use:

a. Landlord leases the premises to Tenant for the purpose of planting, growing, and harvesting crops for consumption and for no other purpose.

b. Tenant agrees to use and occupy the premises in careful and safe manner and not to commit or suffer any waste thereon; maintain the premises in a neat, clean and farmer-like condition; keep the premises free of all trash and litter left by labor crews in and around the farm areas; use due diligence in keeping down all weeds and in preventing the same from going to seed; and Tenant shall not commit, or permit others under Tenant's direction or control to commit, on the leased premises, waste, or a nuisance or any other act that could disturb the quiet enjoyment of Landlord or any other tenant of Landlord on adjacent property.

6. Maintenance, Repairs and Alterations:

a. Landlord shall not be obligated to make any repairs, alterations, additions or improvements in or to or upon the leased premises or any building or other improvement thereon. Tenant shall at all times during the term of this Lease, at his sole cost and expense, keep and maintain all buildings and other improvements on the leased premises in good order and repair.

b. Tenant shall during the term of this Lease properly maintain and repair the reservoir and water pumping facilities connected with Tenant's operation on the leased premises; it being understood and agreed that the water from the reservoir will be used by Tenant for the purposes described herein, as well as used by Landlord for those areas of property owned by Landlord not a part of this Lease and those areas owned by CONEJO MOUNTAIN MEMORIAL PARK which require irrigation. Notwithstanding the foregoing, Landlord has no obligation to maintain, repair, replace, reimburse or partially reimburse Tenant for costs incurred in connection with water pumps and related facilities, pipelines, and/or the maintenance and repair of the reservoir on the leased premises. In addition, Tenant shall not permit the water level in said reservoir to be less than ______one hundred________________ feet (100) above sea level unless the Landlord consents thereto. As a rule of thumb, the water level in the reservoir should be full enough so that cattle can obtain water and the CONEJO MOUNTAIN MEMORIAL PARK can irrigate but low enough so that during the rainy season the reservoir may serve as a retention basin.

b. Tenant shall, in addition to all other sums agreed to be paid by it under this Lease, pay to Landlord upon demand all real estate taxes which shall, during the term of this Lease be assessed against the leased premises in excess of the taxes assessed for the fiscal tax year 1975-1976.

c. The parties hereto acknowledge that the premises described in Exhibit "A" is, as a result of an agreement between MARY H. SMITH and the County of Ventura, included within the agricultural preserve pursuant to the California Land Conservation Act of 1965 as adopted by Ventura County (Ventura County Ordinance Code Section 8120 - 0 et.seq.). In the event MARY H. SMITH violates the terms and conditions of said contract with a resulting penalty assessment and/or an increase in the amount of tax assessment against the leased premises, Tenant shall not be responsible for payment of said increase in tax or penalty assessment. Thereafter, the amount of all real estate taxes levied or assessed against the premises during the term hereof which exceeds the amount of taxes levied or assessed against the premises during the tax year prior to a violation of the Land Conservation Agreement shall be paid by MARY H. SMITH except that the Tenant shall continue to pay the amount of tax in excess, if any, between the 1975-1976 tax year and the tax year prior to the violation of said Land Conservation Agreement by MARY H. SMITH which results in an increase in the tax rate or a penalty assessment.

11. Early and/or Partial Termination:

a. In addition to Tenant's right to terminate this Lease, or portion thereof as provided in paragraph 7, in the event of the death of RAPHAEL BRUCKER, the Tenant, RIP BRUCKER RANCH COMPANY, may elect to terminate this Lease upon giving Landlord written notice six (6) months prior to the actual termination. Furthermore, in the event of the death of RAPHAEL BRUCKER, Landlord shall have the right to terminate this Lease upon giving Tenant written notice one (1) year prior to actual termination with the understanding that the term of this Lease in either event may be extended to the expiration of the harvest of any crop or crops existing at the time of the death of RAPHAEL BRUCKER.

b. MARY H. SMITH, TRUSTEE OF THE MARY H. SMITH TRUST, as owner of that certain three (3) acre parcel of property described in yellow on the map attached as Exhibit "A", shall have the right to terminate this Lease insofar as it affects the approximate three (3) acre parcel of property described in Exhibit "A", upon giving Tenant written notice, sixty (60) days prior to actual termination with the understanding that the actual date of termination will be extended until the expiration of the harvest of any crop or crops then existing on that portion of the leased premises.

c. CONEJO MOUNTAIN MEMORIAL PARK, as owner of a parcel of property described by map in Exhibit "A," attached hereto, may require additional acreage for its operation during the term of this Lease from that area marked in yellow on said map. Upon receipt of written notice, Tenant agrees to terminate this Lease as to that amount of area required by CONEJO MOUNTAIN MEMORIAL PARK. Written notice of termination shall be given Tenant not less than thirty (30) days prior to the harvesting of any crop then growing on that portion of the leased premises. Actual termination shall occur upon the harvesting of said crop or crops upon that portion of the leased premises desired to be used by CONEJO MOUNTAIN MEMORIAL PARK.

d. Partial abatement of Rent: For each acre or fraction thereof that is relinquished by Tenant as a result of any Landlord's exercise of its rights under this paragraph, the rent shall be reduced by per acre for land relinquished within the area designated in blue on the attached map, and per acre for land relinquished within the area designated in black on the attached map.

12. Rights of Others: This Lease is subject to (a) all existing easements, servitudes, licenses, and rights of way or canals, ditches, levees, roads, highways, telegraph, telephone and electric power lines, gas lines, pipelines, and other purposes whether recorded or not, and (b) the rights of other tenants under any existing or future oil, gas and mineral lease or leases from Landlord affecting the entire or any portion of the premises, whether recorded or not.

13. Entry by Owner: Tenant shall permit Landlord, and Landlord's agents and assigns, at all reasonable times, to enter the leased premises, and to use the roads established on the premises now or in the future, for all lawful purposes.

14. Reservations: Landlord reserves all oil, gas and other minerals and substances in and under the leased premises and the right, without joinder of or consent by Tenant, to enter into oil or gas leases affecting the leased premises, or any part thereof, and the rights of Tenant herein at all times shall be subordinate to the rights of any lessee under any such oil or gas lease, subject to crop damage compensation; and Landlord reserves the right to dedicate or convey any portion of the leased premises for street, highway, drainage, sewer, transmission lines or similar purposes, and any portion of said premises so dedicated or so conveyed shall from the date thereof no longer be affected by this Lease; provided, however, that Tenant shall be entitled to an abatement of rent as provided in Paragraph 11d hereof.

15. Alterations: Tenant shall not make, or permit to be made, alterations of the premises, without first obtaining Landlord's consent. Additions to, or alterations of the

premises shall become at once a part of the realty and belong to the Landlord.

16. Compliance: Tenant shall comply with all requirements of all governmental authorities, in force either now or in the future including the terms and provisions of the Land Conservation Act Contract, affecting the premises and shall faithfully observe in its use of the premises all laws, rules, and regulations of these authorities in force either now or in the future. If Tenant fails to comply with any such law, regulation, or rule, Landlord reserves the right to take necessary remedial measures at Tenant's expense, for which Tenant agrees to reimburse Landlord on demand.

17. Landlord's Non-Liability: Landlord shall not be liable for any loss, damage or injury of any kind whatsoever of the person or property of Tenant, or of Tenant's employees, guests, or invitees or of any other person whomsoever, caused by any use of the leased premises, or by any defect in any building, structure or other improvement thereupon, or arising from any accident on said premises or any fire or other casualty thereon, or occasioned by the failure on the part of Tenant to maintain said premises in safe condition, or by any nuisance made or suffered on said premises, or by any act or omission of Tenant, or of any member of Tenant's family, or of Tenant's employees, guests, or invitees, or arising from any other cause whatsoever; and Tenant hereby waives on his behalf all claims and demands against Landlord for any such loss, damage or injury of Tenant, and hereby agrees to indemnify and save Landlord free and harmless from liability for any such loss, damage or injury to other persons, and from all costs, expenses and other charges arising therefrom and in connection therewith.

Tenant shall, at its cost and expense, at all times during the term of this Lease, maintain in force for the joint benefit of Landlord and Tenant, a broad form comprehensive coverage policy of public liability insurance by the terms of which Landlord and Tenant are named as Insured and are indemnified against liability for damage or injury to the property or person (including death) of any Tenant or invitee of Tenant or any other person entering upon or using the leased land, or any structure thereon, or any part thereof, or arising from the use and occupancy thereof. Such insurance policy or policies shall be maintained on the minimum basis of
Thousand Dollars for damage to property,
for bodily injury to wit the death of one (1) person, and
( ) for bodily injury or death in any one (1) accident.

18. Assignment and Subletting: Tenant shall not assign this Lease, or any rights under it, and shall not sublet the entire or any part of the premises, or any right or privilege appurtenant to the premises, or permit any other person (the agents and servants of Tenant excepted) to occupy or use the

entire or any portion of the premises, without first obtaining Landlord's written consent. A consent to one assignment, subletting, occupation, or use by another person is not a consent to a future assignment, subletting, occupation or use by another person. An assignment or a subletting without Landlord's consent shall be void, and shall at Landlord's option, terminate this Lease. No interest of Tenant in this Lease shall be assignable by operation of law without Landlord's written consent.

19. Remedies on Default: Except as otherwise provided herein, should Tenant default in the performance of any covenant or provision herein with reference to the payment of rent or other payment of money, and such default continues for ten (10) days after receipt by Tenant of written notice from Landlord of such default, or should Tenant default in the performance of any other covenant or provision herein, other than the payment of money, and such default, if curable, is not cured within thirty (30) days after service upon Tenant of a written notice thereof from Landlord, or if said default is not curable within thirty (30) days, Tenant fails to commence a cure within thirty (30) days and thereafter fails to diligently prosecute such cure to completion, Landlord shall have the following remedies:

(a) Termination of lease and damages. Landlord may terminate Tenant's right of possession to the leased premises and may recover a sum or sums that shall then be or that shall thereafter become due and payable to Landlord hereunder, and any such termination shall not prevent Landlord from enforcing the payment of any such sum or sums by any remedy provided by law.

(b) Reentry. Landlord may, with or without terminating the lease, reenter the leased premises and take possession thereof after giving the notice of reentry required by law.

(c) Remedies cumulative. None of Landlord's rights herein specified in the event of a default by Tenant shall prejudice any other legal remedies available to Landlord other than those herein enumerated and the remedy described by Civil Code §1951.4 is available to Landlord.

(d) No waiver. Efforts by Landlord to mitigate the damages caused by Tenant's breach of this lease shall not waive Landlord's right to recover damages under this paragraph. For the purpose of subparagraph (a) above, the following shall not constitute a termination of Tenant's right of possession:

(1) Acts of maintenance or preservation or efforts to relet the property;

(2) Appointment of a receiver upon initiative of Landlord to protect Landlord's interest under this lease.

20. Trade Fixtures: Tenant shall retain title to all trade and specialized fixtures which Tenant installs upon the leased premises, such as pipelines. At the termination of this Lease, provided Tenant is not in default, Tenant may remove those fixtures to which it has retained title, provided that upon such removal of fixtures Tenant restores the premises to substantially the same condition as they were at the outset of this Lease.

21. Condemnation:

(a) Definition of terms: The term "total taking" as used in this paragraph means the taking of the entire leased premises under the power of eminent domain or a taking of so much of said land as to prevent or substantially impair the conduct of Tenant's business thereon. The term "partial taking" means the taking of a portion only of said land which does not constitute a total taking as above defined.

(b) Total taking: If during the term hereof there shall be a total taking by public authority under the power of eminent domain, then the leasehold estate of Tenant in and to the leased premises shall cease and terminate as of the date the actual physical possession thereof shall be so taken.

(c) Partial taking: If during said term there shall be a partial taking of the leased premises, this Lease shall terminate as to the portion of said leased premises taken upon the date upon which actual possession of said portion of said leased premises is taken pursuant to said eminent domain proceedings, but said Lease shall continue in force and effect as to the remainder of said leased premises. The rental payable by Tenant for the balance of the Lease term shall be abated in the ratio that the square footage ground area of the leased premises taken bears to the total ground area of said leased premises at the time of such taking.

(d) Allocation of award: All compensation and damages awarded for the taking of the leased premises or any portion thereof shall, except as otherwise herein provided, belong to and be the sole property of Landlord, and Tenant shall not have any claim or be entitled to any award for diminution in value of its leasehold hereunder or for the value of any unexpired term of this Lease; provided, however, that Tenant shall be entitled to any award that may be made for the taking of or injury to Tenant's improvements (including crop damage), or on account of any cost or loss Tenant may ascertain in the removal of Tenant's fixtures, equipment and furnishings, or as a result of any alterations, modifications or repairs which may be reasonably required by Tenant in order to place the remaining portion of the leased premises not so condemned in a suitable condition for the continuance of Tenant's tenancy. Other than as hereinabove provided, Tenant irrevocably assigns and transfers to Landlord any right to compensation or damages to which Tenant may become entitled during the term of this Lease by the condemnation of the entire or a part of the leased premises.

(e) Effect of termination: If this Lease is terminated, in whole or in part, pursuant to any of the provisions of this paragraph, all rentals and other charges payable by Tenant to Landlord hereunder and attributable to the leased premises taken, shall be paid up to the date upon which actual physical possession shall be taken by the condemnor, and the parties shall thereupon be released from all further liability in relation thereto.

(f) Voluntary conveyance: A voluntary conveyance by Landlord to a public utility, agency or authority under threat of taking under the power of eminent domain in lieu of formal proceedings shall be deemed a taking within the meaning of this paragraph.

22. Attorneys' Fees: In any action or proceeding by either party to enforce this Lease or any provision hereof, the prevailing party shall be entitled to all costs incurred and to reasonable attorneys' fees.

23. Notices: Any notice to be given to either party by the other shall be in writing and shall be served either personally or by mail, postage prepaid, addressed as follows: Landlord, c/o MARY H. SMITH, TRUSTEE, 1767 Pancho Road, Camarillo, California 93010; Tenant, RAPHAEL BRUCKER, 1090 Pancho Road, Camarillo, California 93010.

24. Surrender and Removal:

(a) Upon the expiration of the term of this Lease or any earlier termination thereof, Tenant shall surrender to Landlord possession of the leased premises and all improvements (trade fixtures excepted) constructed and installed thereon in the same condition as when received, reasonable use, wear, tear and damage by fire, act of God or the elements excepted. In addition, Tenant shall disc the soil in suitable condition for the growing of other crops upon surrender of the leased premises or any portion thereof.

(b) Upon the expiration of the Lease term, or any sooner termination of this Lease, Tenant agrees to execute, acknowledge and deliver to Landlord a proper instrument, in writing, releasing and quitclaiming to Landlord all right, title and interest of Tenant in and to the leased premises and all improvements thereon.

25. Legal Effect: All covenants of Tenant contained in this Lease are expressly made conditions.

The provisions of this Lease shall, subject to the provisions on Assignment - Subletting, apply to and bind the heirs, successors, executors, administrators and assign of all parties to this Lease; and all parties to this Lease shall be jointly and severally liable under it.

26. First Refusal: Landlord shall have the right to negotiate a lease with third parties upon terms and conditions satisfactory to Landlord, the term of said lease to be subsequent in time to the lease term as described herein. If Landlord does negotiate a lease with a third party(ies) on terms and conditions satisfactory to Landlord, then Landlord shall give the Tenant the right to extend the term of this Lease for the period of time and on the same terms and conditions as negotiated between Landlord and said third party(ies). Tenant shall have thirty (30) days within which to exercise its right to extend the term of this Lease upon the same terms and conditions as offered to said third party(ies). If Tenant does not exercise its rights within the time limit described herein, Landlord thereafter shall have the right to lease the lease premises, or any portion thereof, to a third party(ies) without further obligation to Tenant upon termination of the lease term. If the Tenant exercises the rights as described herein, the parties shall immediately execute an amendment to this Lease incorporating the same terms and conditions as offered to said third party(ies).

IN WITNESS WHEREOF, the parties hereto have executed this Lease as of the date first above written, signed by all of the Landlords and by the Tenant.

RIP BRUCKER RANCH CO.,
a California corporation

By
By

"Tenant"

Mary H. Smith
MARY H. SMITH, TRUSTEE

JOSEPH E. HOWARD

Patricia C. Howard
PATRICIA C. HOWARD

CONEJO MOUNTAIN MEMORIAL PARK,
a California corporation

By

"Landlord"

EXHIBIT "A"

Attached to this Exhibit "A" are two maps which incorporate the leased premises. The area within the red markings consist of 185.1 acres. The annual rent for said acreage is per acre, or The area within the blue markings consists of 93.8 acres. The annual rent for said acreage is per acre or The acreage within the black markings consists of 82 acres. The annual rent for said acreage is per acre or The total annual rent is

The taxes attributable to the leased premises for the 1975-76 fiscal tax year were $ The taxes attributable to the leased premises for the 1976-77 fiscal tax year are The tax increase from 1975-76 is The tax base for the computation of additional increases in real property taxes and assessments attributable to the leased premises is

The property comprising the leased premises is located in Ventura County, California, and represents portions of Ventura County tax assessor parcel nos. 234-0-040-120; 234-0-060-040; 234-0-060-150; 234-0-040-110 (Joseph Richard Howard's 2 acre parcel North of Conejo Creek); 234-0-060-120 (Cemetery); and 234-0-060-140 (Joseph Richard Howard's residential property).

The areas designated in yellow on the attached maps are those areas where the landlord is reserving the right to terminate said portions of property from the terms of this lease pursuant to the terms and conditions of paragraph 11 of said lease.

CAMARILLO CONTROL SITE LEASE

FARM LEASE

LOT 5

RECEIVED
FEB -3 1978
Ralph Stone & Co.
Los Angeles, Ca.

This farm lease is entered into by and between the FitzGerald Ranch Management, a joint venture, hereafter referred to as "Landlord" and Michael Brucker, hereafter referred to as "Tenant".

The parties agree that:

1. LEASED PROPERTY. Landlord hereby leases to Tenant and Tenant hires from Landlord on the terms and conditions hereinafter set forth those certain premises situated in the County of Ventura, California, consisting of 41.77 acres described on Exhibit A attached hereto and incorporated herein by reference.

3. USE OF THE LEASED PREMISES. Tenant shall use the leased premises solely for the purpose of planting, cultivating and harvesting crops at Tenant's own expense.

5. WATER. Water necessary for the irrigation of the crops to be grown on the leased premises by Tenant shall be available to Tenant from well number 2, located on Lot 5, Rancho Calleguas, subject to the following terms and limitations:

(a) The right to use water pertains only to Landlord's 19.9 percent share of the water from the well (number 2) on Lot 5 as set forth in a Water Agreement as to Producing Water Well and Trans Lines dated March 12, 1965, a copy of which is attached hereto as Exhibit B as modified by, and subject to the provisions of a letter dated from Haskins and Sells, a copy of which is attached hereto as Exhibit C.

(b) Water from well number 2 shall be used only on the leased premises and shall be used only for Tenant's farming under this lease. Tenant shall not export water from well number 2 to lands other than the leased premises for use thereon.

(c) Landlord shall not be liable to Tenant for any water shortage from well number 2 and does not warrant the quality or quantity of the water available from well number 2 or any other source will be suitable or sufficient for Tenant's farming operations under this lease.

If Tenant is unable to obtain sufficient water for farming operations from the leased premises from well number 2, the City of Camarillo, or another purveyor of water, Tenant may terminate this lease with the termination to be effective ninety (90) days after Tenant has served written notice of termination upon Landlord invoking the termination provision of this paragraph.

Tenant may use the underground concrete pipelines stands and irrigation pots for irrigation purposes and Tenant acknowledges same are now in good condition. Tenant shall pay for any and all repairs, leaks or damage to pipelines that may develop during the term of this lease. Tenant shall not relocate any underground pipelines without first obtaining Landlord's consent to such relocation.

6. WATER CHARGES AND METER READINGS. Tenant shall pay Landlord monthly for water the amounts due and payable in accordance with the letter from Haskins & Sells dated and attached hereto as Exhibit C.

7. RESTORATION OF LAND. Prior to Tenant shall disc the land twice and to the extent directed by Landlord shall restore the leased property to the condition in which it was received or to such improved condition as may have resulted from any improvement made thereon by Landlord or Tenant during the term of this lease.

8. TERMINATION. Landlord, at its option, may terminate this lease in the event Tenant fails to perform any obligation to be performed by him herein or does some act prohibited herein. This lease shall terminate on the date a written notice of termination specifying Tenant's default or breach of lease and Landlord's election to terminate the lease is served in the manner provided by paragraph 13 of this lease unless, in the case of a default, such default is cured within ten (10) days after service of such notice.

9. SURRENDER. Upon the expiration of this lease, or its prior termination, Tenant shall quietly and peacefully vacate the leased premises and surrender the possession thereof to Landlord.

after deposit in the United States mail.

14. COMPLIANCE WITH LAW. Tenant shall, at its own cost and expense, conduct all operations on the premises in accordance with all applicable state, county and municipal statutes and ordinances and in accordance with regulations issued by the State Department of Agriculture, State Department of Public Health and the Health Officer of Ventura County.

15. LIENS. Tenant shall promptly discharge or cause to be discharged any valid lien, right in rem., claim or demand of any kind, except one in favor of Landlord, arising, or existing with respect to the leased premises or for materials or equipment furnished therefore or for any part thereof. If any lien is not promptly discharged by Tenant, Landlord may discharge the same and Tenant shall reimburse Landlord for the cost thereof.

16. WASTE. Tenant shall not commit or suffer to be committed any waste upon said premises, or any nuisance or other act or thing which may disturb the quiet enjoyment of persons occupying land surrounding the leased premises except noise or disturbance from the use of the premises as provided in this lease.

17. FAILURE TO INSIST ON COMPLIANCE. Landlord's failure to take advantage of any default or breach of covenant on the part of Tenant or to insist upon the performance of any of the terms, covenants and conditions of this lease shall not be a waiver or relinquishment of Landlord's right to the future performance of such terms, covenants and conditions. Tenant's obligations with respect to such future performance shall continue in full force and effect. No custom or practice which may develop between the

parties in the course of administering this lease shall be construed to waive or lessen the right of Landlord to insist upon the performance by Tenant of any term, covenant or condition thereof.

18. SUCCESSORS IN INTEREST. Terms, covenants, and conditions contained herein shall apply to and bind the successors, heirs and assigns of both parties hereto.

19. ATTORNEYS' FEES. In the event suit shall be brought for the recovery of any rent to be paid by Tenant under this lease or because of Tenant's breach of any other provisions herein, Tenant shall pay to Landlord reasonable attorneys' fees as fixed by the court.

20. WEEDS AND PESTS. Tenant shall, during the term of this lease, control all weeds, noxious or otherwise, growing on the leased premises and the margin of any roads adjacent thereto. Tenant shall, during the term of this lease, furnish all materials and labor necessary to poison and otherwise control all rodents and other pests on the premises.

21. CONDEMNATION. If the leased property or any part thereof is taken by condemnation, or incident to the exercise of the power of eminent domain (hereinafter referred to as "condemnation") the following shall apply:

(a) Termination of the Lease. If the entire leased property is taken or acquired by condemnation this lease shall terminate, such termination to take effect as of the date taking becomes effective by the passage of title to the leased property to the condemning authority pursuant to court order or by the physical taking of possession of the leased property by the condemning authority whichever is earlier.

If only a portion of the leased premises is taken or acquired by or incident to condemnation and a part thereof remains which can be used for farming purposes, this lease shall, except to the part actually taken, remain in full force and effect.

(b) Adjustment in Rent. If only a portion of the leased property is taken by condemnation and a part thereof remains which can be used for farming purposes, rent payable under this lease shall be adjusted as follows:

$$\text{Rent payable after date of taking} = \frac{\text{Area of leased property remaining after condemnation}}{\text{Area of leased property before condemnation}} \times \text{Rent payable prior to condemnation}$$

Such adjustment in rent shall take effect on the date title passes to the condemning authority pursuant to court order or on the date the condemming authority takes physical possession of the property, whichever is earlier.

(c) Apportionment of Condemnation Award. For purposes of this lease the crops grown on the leased property by Tenant shall be considered personalty. Unless the fair market value of the crops growing on the leased property taken at the time of taking is determined to be a part of the realty in fixing the fair market value of the realty in the condemnation proceeding, Tenant shall not be entitled to any portion of the condemnation award and Tenant as partial consideration for execution of this lease hereby assigns to Landlord all compensation to which he may be entitled by law by reason of the condemnation.

If the fair market value of the crops growing on the leased property taken is determined to be a part of the realty in fixing the fair market value of the realty in the condemnation proceeding, Tenant shall be entitled to receive the difference, if any, between the fair market value of the crops on the portion of the leased property taken at the time of taking and the proceeds, if any, actually received by Tenant from the harvest and sale of said crops.

For purposes of this subparagraph the leased property shall be considered "taken" when a summons is issued in the condemnation proceeding, or when the condemning authority takes physical possession of the portion of the leased property taken, whichever is earlier.

22. OIL AND GAS LEASE. Landlord shall have the right during the lease term to lease the leased property to persons other than Tenant for the purpose of taking oil and gas therefrom. Tenant shall have the right to designate any drilling sites on the leased premises and any routes of ingress and egress and Landlord will consult with Tenant prior to entering into any oil and gas lease for the purpose of fixing the location of drilling sites and routes of ingress and egress. Any such oil and gas lease shall provide for compensation to Tenant for the fair market value of any crops destroyed or damaged by reason of exploration or production under the oil and gas lease.

23. FLOODING. Landlord does not warrant the sufficiency of any apparent work or provision made for the control of flooding on the leased premises and does not warrant any work for the control of flooding of the leased premises has been made and does not warrant that the leased premises will not flood.

Beginning at a point in the north line of Lot 5, Rancho Calleguas, in the County of Ventura, State of California, as per map recorded in Book 17, page 16 of Maps, distant North 89° 53' West 2611.56 feet from the northeast corner of said Lot 5, thence

1st: - South 0° 03' 30" East 2331.05 feet to the north line of the land described as PARCEL 1 in deed to the state of California recorded in book 1555, page 114 of Official Records, thence along said north line

2nd: - South 89° 55' 38" West 73.29 feet to the easterly line of the land described as PARCEL 5 in deed to the state of California recorded in book 1136, page 320 of Official Records, thence along the boundary of said land by the following three courses

3rd: - North 21° 52' 27" West 10.77 feet, thence

4th: - South 89° 55' 38" West 20.00 feet, thence

5th: - South 21° 43' 43" West 10.77 feet to the north line of said PARCEL 1, thence along said north line

6th: - South 89° 55' 38" West 685.31 feet, thence

7th: - North 1° 38' 02" West 2183.87 feet to the beginning of a tangent curve concave easterly having a radius of 382 feet, thence

8th: - Northerly along said curve through an angle of 19° 40' 17", an arc distance of 131.15 feet to the northwesterly line of said Lot 5, thence along the boundary of said Lot by the following two courses

9th: - North 40° 40' East 28.39 feet, thence

10th: -South 89° 53' East 809.38 feet to the point of beginning.

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EXHIBIT A

(c) Notwithstanding the termination date as above provided, the termination shall be subject to Tenant's right to complete the growing and harvesting of crops on the leased premises at the time the notice of intent to terminate has been given with acreage to be surrendered by Tenant as harvest is completed.

(d) There shall be an abatement of rentals for the remainder of the term of the lease in proportion to the acreage sole and surrendered by Tenant and any prepaid rents with respect to such acreage shall be returned to Tenant at the time of sale.

(e) Tenant shall have the right to terminate the lease as of the termination date (or completion of crop harvest) if the portion of the premises sold would leave the remainder an uneconomical unit for the farming purposes of Tenant.

27. CAPTIONS. The captions to the paragraphs of this lease are not a part of the provisions thereof.

Executed on ____,

FITZGERALD RANCH MANAGEMENT, a
joint venture,

By ______________________
GERALD FITZGERALD

By JAMES FITZGERALD
JAMES FITZGERALD
Landlord

____
MICHAEL BRUCKER
Tenant

GLOSSARY

boreholes: Subsurface exploration holes drilled or excavated to obtain earth samples. Boreholes may be drilled to any depth for soil and leachate samples, test well installation, and groundwater aquifer detection.

groundwater: The upper aquifer that receives the percolated irrigation water.

lysimeter: A porous ceramic-tipped cup device used to extract, when a vacuum is applied, a sample of percolating water from subsoil.

spatula: A sterilized hand tool in a protective wrapper used to collect uncontaminated soil samples.

tail water: The surface runoff water from an irrigated field.

test well: A special well constructed into the upper aquifer groundwater for sampling the groundwater.

well baler or well pump: Devices that may be used for pumping and obtaining groundwater samples from test wells. Varies in size depending on the well diameter. Well balers may consist of a weight, a test tube, a stopper, and a cord for collecting samples in a well. Well pumps are mechanical devices used to extract water from a well.